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ZOONOMIA;

OR,

THE LAWS

OF

ORGANIC LIFE.

IN FOUR VOLUMES.

By ERASMUS DARWIN, M.D. F.R.S.

AUTHOR OF THE BOTANIC GARDEN.

Principiò cœlum, ac terras, campoſque liquentes,
Lucentemque globum lunæ, titaniaque aſtra,
Spiritus intùs alit, totamque infuſa per artus
Mens agitat molem, et magno ſe corpore miſcet.
VIRG. ÆN. VI.

Earth, on whoſe lap a thouſand nations tread,
And Ocean, brooding his prolific bed,
Night's changeful orb, blue pole, and ſilvery zones,
Where other worlds encircle other ſuns,
One mind inhabits, one diffuſive Soul
Wields the large limbs, and mingles with the whole.

VOL. II.

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ZOONOMIA.

SECT. XXX.

PARALYSIS OF THE LIVER AND KIDNEYS.

I. *Bile-ducts leſs irritable after having been ſtimulated much. 2. Jaundice from paralyſis of the bile-ducts cured by electric ſhocks. 3. From bile-ſtones. Experiments on bile-ſtones. Oil vomit 4. Palſy of the liver, two caſes. 5. Scirrhoſity of the liver. 6. Large livers of geeſe.* II. *Paralyſis of the kidneys.* III. *Story of Prometheus.*

1. From the ingurgitation of ſpirituous liquors into the ſtomach and duodenum, the termination of the common bile-duct in that bowel becomes ſtimulated into unnatural action, and a greater quantity of bile is produced from all the ſecretory veſſels of the liver, by the aſſociation of their motions with thoſe of their excretory ducts; as has been explained in Section XXIV. and XXV. but as all parts of the body, that have been affected with ſtronger ſtimuli for any length of time, become leſs ſuſceptible of motion, from their natural weaker ſtimuli, it follows, that the motions of the ſecretory veſſels, and in

conſequence the ſecretion of bile, is leſs than is natural during the intervals of ſobriety. 2. If this ingurgitation of ſpirituous liquors has been daily continued in conſiderable quantity, and is then ſuddenly intermitted, a languor or paralyſis of the common bile-duct is induced; the bile is prevented from being poured into the inteſtines; and as the bilious abſorbents are ſtimulated into ſtronger action by its accumulation, and by the acrimony or viſcidity, which it acquires by delay, it is abſorbed, and carried to the receptacle of the chyle; or otherwiſe the ſecretory veſſels of the liver, by the above-mentioned ſtimulus, invert their motions, and regurgitate their contents into the blood, as ſometimes happens to the tears in the lachrymal ſack, ſee Sect. XXIV. 2. 7. and one kind of jaundice is brought on.

There is reaſon to believe, that the bile is moſt frequently returned into the circulation by the inverted motions of theſe hepatic glands, for the bile does not ſeem liable to be abſorbed by the lymphatics, for it ſoaks through the gall-ducts, and is frequently found in the cellular membrane. This kind of jaundice is not generally attended with pain, neither at the extremity of the bile-duct, where it enters the duodenum, nor on the region of the gall-bladder.

Mr. S. a gentleman between forty and fifty years of age, had had the jaundice about ſix weeks, without pain, ſickneſs, or fever; and had taken emetics, cathartics, mercurials, bitters, chalybeates, eſſential oil, and æther, without apparent advantage. On a ſuppoſition that the obſtruction of the bile might be owing to the paralyſis, or torpid action of the common bile-duct, and the ſtimulants taken into the ſtomach ſeeming to have no effect, I directed half a ſcore ſmart electric ſhocks from a coated bottle, which held about a quart, to be paſſed through the liver, and along the courſe of the common gall-duct, as near as could be gueſſed, and on that very day the ſtools became yellow; he continued the electric ſhocks a few days more, and his ſkin gradually became clear.

3. The bilious vomiting and purging, that affects ſome people by intervals of a few weeks, is a leſs degree of this diſeaſe; the bile-duct is leſs irritable than natural, and hence the bile becomes accumulated in the gall-bladder, and hepatic ducts, till by its quantity, acrimony or viſcidity, a greater degree of irritation is produced, and it is ſuddenly evacuated, or laſtly from the abſorption of the more liquid parts of the bile, the remainder becomes inſpiſſated, and chryſtallizes into maſſes too large to paſs, and forms another kind of jaundice, where the bile-duct is not quite paralytic, or has regained its irritability.

This diſeaſe is attended with much pain, which at firſt is felt at the pit of the ſtomach, exactly in the centre of the body, where the bile-duct enters the duodenum; afterwards, when the ſize of the bile-ſtones increaſe, it is alſo felt on the right ſide, where the gall-bladder is ſituated. The former pain at the pit of the ſtomach recurs by intervals, as the bile-ſtone is puſhed againſt the neck of the duct; like the paroxyſms of the ſtone in the urinary bladder, the other is a more dull and conſtant pain.

Where theſe bile-ſtones are too large to paſs, and the bile-ducts poſſeſs their ſenſibility, this becomes a very painful and hopeleſs diſeaſe. I made the following experiments with a view to their chemical ſolution.

Some fragments of the ſame bile-ſtone were put into the weak ſpirit of marine ſalt, which is ſold in the ſhops; and into ſolution of mild alcali; and into a ſolution of cauſtic alcali; and into oil of turpentine; without their being diſſolved. All theſe mixtures were after ſome time put into a heat of boiling water, and then the oil of turpentine diſſolved its fragments of bile-ſtone, but no alteration was produced upon thoſe in the other liquids except ſome change of their colour.

Some fragments of the ſame bile-ſtone were put into vitriolic æther, and were quickly diſſolved without additional heat. Might not æther mixed with yolk of egg or with honey be given advantageouſly in bilious concretions?

I have in two inſtances ſeen from thirty to fifty bile-ſtones come away by ſtool, about the ſize of large peas, after having given ſix grains of calomel in the evening, and four ounces of oil of almonds or olives on the ſucceeding morning. I have alſo given half a pint of good olive or almond oil as an emetic during the painful fit, and repeated it in half an hour, if the firſt did not operate, with frequent good effect.

4. Another diſeaſe of the liver, which I have ſeveral times obſerved, conſiſts in the inability or paralyſis of the ſecretory veſſels. This diſeaſe has generally the ſame cauſe as the preceding one, the too frequent potation of ſpirituous liquors, or the too ſudden omiſſion of them, after the habit is confi~~ne~~d; and is greater or leſs in proportion, as the whole or a part of the liver is affected, and as the inability or paralyſis is more or leſs complete.

This palſy of the liver is known from theſe ſymptoms, the patients have generally paſſed the meridian of life, have drunk fermented liquors daily, but perhaps not been opprobrious drunkards; they loſe their appetite, then their fleſh and ſtrength diminiſh in conſequence, there appears no bile in their ſtools, nor in their urine, nor is any hardneſs or ſwelling perceptible in the region of the liver. But what is peculiar to this diſeaſe, and diſtinguiſhes it from all others at the firſt glance of the eye, is the bombycinous colour of the ſkin, which, like that of full-grown ſilkworms, has a degree of tranſparency with a yellow tint not greater than is natural to the ſerum of the blood.

Mr. C. and Mr. B. both very ſtrong men, between fifty and ſixty years of age, who had drunk ale at their meals inſtead of ſmall beer, but were not reputed hard-drinkers, ſuddenly became weak, loſt their appetite, fleſh and ſtrength, with all the ſymptoms above enumerated, and died in about two months from the beginning of their malady. Mr. C. became anaſarcous a few days before his death, and Mr. B. had frequent and great hæmorrhages from an iſſue, and ſome parts of his mouth, a few days before his death. In both theſe caſes calomel, bitters, and chalybeates were repeatedly uſed without effect.

One of the patients deſcribed above, Mr. C. was by trade a plumber; both of them could digeſt no food, and died apparently for want of blood. Might not the transfuſion of blood be uſed in theſe caſes with advantage?

5. When the paralyſis of the hepatic glands is leſs complete, or leſs univerſal, a ſcirrhoſity of ſome part of the liver is induced; for the ſecretory veſſels retaining ſome of their living power take up a fluid from the circulation, without being ſufficiently irritable to carry it forwards to their excretory ducts; hence the body, or receptacle of each gland, becomes inflated, and

this diſtention increaſes, till by its very great ſtimulus inflammation is produced, or till thoſe parts of the viſcus become totally paralytic. This diſeaſe is diſtinguiſhable from the foregoing by the palpable hardneſs or largeneſs of the liver; and as the hepatic glands are not totally paralytic, or the whole liver not affected, ſome bile continues to be made. The inflammations of this viſcus, conſequent to the ſcirrhoſity of it, belong to the diſeaſes of the ſenſitive motions, and will be treated of hereafter.

6. The ancients are ſaid to have poſſeſſed an art of increaſing the livers of geeſe to a ſize greater than the remainder of the gooſe. Martial. l. 13. epig. 58.—This is ſaid to have been done by fat and figs. Horace. l. 2. ſat. 8.—Juvenal ſets theſe large livers before an epicure as a great rarity. Sat. 5 l. 114; and Perſius, ſat. 6. l. 71. Pliny ſays theſe large gooſe-livers were ſoaked in mulled milk, that is, I ſuppoſe, milk mixed with honey and wine; and adds, "that it is uncertain whether Scipio Metellus, of conſular dignity, or M. Seſtius, a Roman knight, was the great diſcoverer of this excellent diſh." A modern traveller, I believe Mr. Brydone, aſſerts that the art of enlarging the livers of geeſe ſtill exiſts in Sicily; and it is to be lamented that he did not import it into his native country, as ſome method of affecting the human liver might perhaps have been collected from it;

beſides the honour he might have acquired in improving our giblet pies.

Our wiſer caupones, I am told, know how to fatten their fowls, as well as their geeſe, for the London markets, by mixing gin inſtead of figs and fat with their food; by which they are ſaid to become ſleepy, and to fatten apace, and probably acquire enlarged livers; as the ſwine are aſſerted to do, which are fed on the ſediments of barrels in the diſtilleries; and which ſo frequently obtains in thoſe, who ingurgitate much ale, or wine, or drams.

II. The irritative diſeaſes of the kidneys, pancreas, ſpleen, and other glands, are analogous to thoſe of the liver above deſcribed, differing only in the conſequences attending their inability to action. For inſtance, when the ſecretory veſſels of the kidneys become diſobedient to the ſtimulus of the paſſing current of blood, no urine is ſeparated or produced by them; their excretory mouths become filled with concreted mucus, or calculous matter, and in eight or ten days ſtupor and death ſupervene in conſequence of the retention of the feculent part of the blood.

This diſeaſe in a ſlighter degree, or when only a part of the kidney is affected, is ſucceeded by partial inflammation of the kidney in conſequence of previous torpor. In that caſe greater actions of the ſecretory veſſels occur, and the nucleus of gravel is formed by the inflamed mucous membranes of the tubuli uriniferi, as farther explained in its place.

This torpor, or paralyſis of the ſecretory veſſels of the kidneys, like that of the liver, owes its origin to their being previouſly habituated to too great ſtimulus; which in this country is generally owing to the alcohol contained in ale or wine; and hence muſt be regiſtered amongſt the diſeaſes owing to inebriety; though it may be cauſed by whatever occaſionally inflames the kidney; as too violent riding on horſeback, or the cold from a damp bed, or by ſleeping on the cold ground; or perhaps by drinking in general too little aqueous fluids.

III. I ſhall conclude this ſection on the diſeaſes of the liver induced by ſpirituous liquors, with the well known ſtory of Prometheus, which ſeems indeed to have been invented by phyſicians in thoſe ancient times, when all things were clothed in hieroglyphic, or in fable. Prometheus was painted as ſtealing fire from heaven, which might well repreſent the inflammable ſpirit produced by fermentation; which may be ſaid to animate or enliven the man of clay: whence the conqueſts of Bacchus, as well as the temporary mirth and noiſe of his devotees. But the after puniſhment of thoſe, who ſteal this accurſed fire, is a vulture gnawing the liver; and well allegoriſes the poor inebriate lingering for years under painful hepatic diſeaſes. When the expediency of laying a further tax on the diſtillation of ſpirituous liquors from grain was canvaſſed before the Houſe of Commons ſome years ago, it was ſaid of the diſtillers, with great truth, "*They take the bread from the people, and convert it into poiſon!*" Yet is this manufactory of diſeaſe permitted to continue, as appears by its paying into the treaſury above 900,000*l.* near a million of money annually. And thus, under the names of rum, brandy, gin, whiſky, uſquebaugh, wine, cyder, beer, and porter, alcohol is become the bane of the Chriſtian world, as opium of the Mahometan.

Evoe! parce, Liber,
Parce, gravi metuende thyrſo!
Hor.

SECT. XXXI.

OF TEMPERAMENTS.

I. *The temperament of decreaſed irritability known by weak pulſe, large pupils of the eyes, cold extremities. Are generally ſuppoſed to be too irritable. Bear pain better than labour. Natives of North-America contraſted with thoſe upon the coaſt of Africa. Narrow and broad ſhouldered people. Irritable conſtitutions bear labour better than pain.* II. *Temperament of increaſed ſenſibility. Liable to intoxication, to inflammation, hæmoptoe, gutta ſerena, enthuſiaſm, delirium, reverie. Theſe conſtitutions are indolent to voluntary exertions, and dull to irritations. The natives of South-America, and brute animals of this temperament.* III. *Of increaſed voluntarity; theſe are ſubject to locked jaw, convulſions, epilepſy, mania. Are very active, bear cold, hunger, fatigue. Are ſuited to great exertions. This temperament diſtinguiſhes mankind from other animals.* IV. *Of increaſed aſſociation. Theſe have great memories, are liable to quartan agues, and ſtronger ſympathies of parts with each other.* V. *Change of temperaments into one another.*

Ancient writers have ſpoken much of temperaments, but without ſufficient preciſion. By temperament of the ſyſtem ſhould be meant a permanent prediſpoſition to certain claſſes of diſeaſes: without this definition a temporary prediſpoſition to every diſtinct malady might be termed a temperament. There are four kinds of conſtitution, which permanently deviate from good health, and are perhaps ſufficiently marked to be diſtinguiſhed from each other, and conſtitute the temperaments or prediſpoſitions to the irritative, ſenſitive, voluntary, and aſſociate claſſes of diſeaſes.

I. *The Temperament of decreaſed Irritability.*

The diſeaſes, which are cauſed by irritation, moſt frequently originate from the defect of it; for thoſe, which are immediately owing to the exceſs of it, as the hot fits of fever, are generally occaſioned by an accumulation of ſenſorial power in conſequence of a previous defect of irritation, as in the preceding cold fits of fever. Whereas the diſeaſes, which are cauſed by ſenſation and volition, moſt frequently originate from the exceſs of thoſe ſenſorial powers, as will be explained below.

The temperament of decreaſed irritability appears from the following circumſtances, which ſhew that the muſcular fibres or organs of ſenſe are liable to become torpid or quieſcent from leſs defect of ſtimulation than is productive of torpor or quieſcence in other conſtitutions.

1. The firſt is the weak pulſe, which in ſome conſtitutions is at the ſame time quick. 2. The next moſt marked criterion of this temperament is the largeneſs of the aperture of the iris, or pupil of the eye, which has been reckoned by

ſome a beautiful feature in the female countenance, as an indication of delicacy, but to an experienced obſerver it is an indication of debility, and is therefore a defect, not an excellence. The third moſt marked circumſtance in this conſtitution is, that the extremities, as the hands and feet, or noſe and ears, are liable to become cold and pale in ſituations in reſpect to warmth, where thoſe of greater ſtrength are not affected. Thoſe of this temperament are ſubject to hyſteric affections, nervous fevers, hydrocephalus, ſcrofula, and conſumption, and to all other diſeaſes of debility.

Thoſe, who poſſeſs this kind of conſtitution, are popularly ſuppoſed to be more irritable than is natural, but are in reality leſs ſo. This miſtake has ariſen from their generally having a greater quickneſs of pulſe, as explained in Sect. XII. 1. 4. XII. 3. 3; but this frequency of pulſe is not neceſſary to the temperament, like the debility of it.

Perſons of this temperament are frequently found amongſt the ſofter ſex, and amongſt narrow-ſhouldered men; who are ſaid to bear labour worſe, and pain better than others. This laſt circumſtance is ſuppoſed to have prevented the natives of North America from having been made ſlaves by the Europeans. They are a narrow-ſhouldered race of people, and will rather expire under the laſh, than be made to labour. Some nations of Aſia have ſmall hands, as may be ſeen by the handles of their ſcymetars; which with their narrow ſhoulders ſhew, that they have not been accuſtomed to ſo great labour with their hands and arms, as the European nations in agriculture, and thoſe on the coaſts of Africa in ſwimming and rowing. Dr. Manningham, a popular accoucheur in the beginning of this century, obſerves in his aphoriſms, that broad ſhouldered men procreate broad-ſhouldered children. Now as labour ſtrengthens the muſcles employed, and increaſes their bulk, it would ſeem that a few generations of labour or of indolence may in this reſpect change the form and temperament of the body.

On the contrary, thoſe who are happily poſſeſſed of a great degree of irritability, bear labour better than pain; and are ſtrong, active, and ingenious. But there is not properly a temperament of increaſed irritability tending to diſeaſe, becauſe an increaſed quantity of irritative motions generally induces an increaſe of pleaſure or pain, as in intoxication, or inflammation; and then the new motions are the immediate conſequences of increaſed ſenſation, not of increaſed irritation; which have hence been ſo perpetually confounded with each other.

II. *Temperament of Senſibility.*

There is not properly a temperament, or a prediſpoſition to diſeaſe, from decreaſed ſenſibility, ſince irritability and not ſenſibility is immediately neceſſary to bodily health. Hence it is the exceſs of ſenſation alone, as it is the defect of irritation, that moſt frequently produces diſeaſe. This temperament of increaſed ſenſibility is known from the increaſed activity of all thoſe motions of the organs of ſenſe and muſcles, which are exerted in conſequence of pleaſure or pain, as in the beginning of drunkenneſs, and in inflammatory fever. Hence thoſe of this conſtitution are liable to inflammatory diſeaſes, as hepatitis; and to that kind of conſumption which is hereditary, and commences with ſlight repeated hæmoptoe. They have high-coloured lips, frequently dark hair and dark eyes with large pupils, and are in that caſe ſubject to gutta ſerena. They are liable to enthuſiaſm, delirium, and reverie. In this laſt circumſtance they are liable to ſtart at the clapping of a door; becauſe the more intent any one is on the paſſing current of his ideas, the greater ſurpriſe he experiences on their being diſſevered by ſome external violence, as explained in Sect. XIX. on reverie.

As in theſe conſtitutions more than the natural quantities of ſenſitive motions are produced by the increaſed quantity of ſenſation exiſting in the habit, it follows, that the irritative motions will be performed in ſome degree with leſs energy, owing to the great expenditure of ſenſorial power on the ſenſitive ones. Hence thoſe of this temperament do not attend to ſlight ſtimulations, as explained in Sect. XIX. But when a ſtimulus is ſo great as to excite ſenſation, it produces greater ſenſitive actions of the ſyſtem than in others; ſuch as delirium or inflammation. Hence they are liable to be abſent in company; ſit or lie long in one poſture; and in winter have the ſkin of their legs burnt into various colours by the fire. Hence alſo they are fearful of pain; covet muſic and ſleep; and delight in poetry and romance.

As the motions in conſequence of ſenſation are more than natural, it alſo happens from the greater expenditure of ſenſorial power on them, that the voluntary motions are leſs eaſily exerted. Hence the ſubjects of this temperament are indolent in reſpect to all voluntary exertions, whether of mind or body.

A race of people of this deſcription ſeems to have been found by the Spaniards in the iſlands of America, where they firſt landed, ten of whom are ſaid not to have conſumed more food than one Spaniard, nor to have been capable of more than one tenth of the exertion of a Spaniard. Robertſon's Hiſtory.—In a ſtate ſimilar to this the greateſt part of the animal world paſs their lives, between ſleep and inactive reverie, except when they are excited by the call of hunger.

III. *The Temperament of increaſed Voluntarity.*

Those of this conſtitution differ from both the laſt mentioned in this, that the pain, which gradually ſubſides in the firſt, and is productive of inflammation or delirium in the ſecond, is in this ſucceeded by the exertion of the muſcles or ideas, which are moſt frequently connected with volition; and they are thence ſubject to locked jaw, convulſions, epilepſy, and mania, as explained in Sect. XXXIV. Thoſe of this temperament attend to the ſlighteſt irritations or ſenſations, and immediately exert themſelves to obtain or avoid the objects of them; they can at the ſame time bear cold and hunger better than others, of which Charles the Twelfth of Sweden was an inſtance. They are ſuited and generally prompted to all great exertions of genius or labour, as their deſires are more extenſive and more vehement, and their powers of attention and of labour greater. It is this facility of voluntary exertion, which diſtinguiſhes men from brutes, and which has made them lords of the creation.

IV. *The Temperament of increaſed Aſſociation.*

This conſtitution conſiſts in the too great facility, with which the fibrous motions acquire habits of aſſociation, and by which theſe aſſociations become proportionably ſtronger than in thoſe of the other temperaments. Thoſe of this temperament are ſlow in voluntary exertions, or in thoſe dependent on ſenſation, or on irritation. Hence great memories have been ſaid to be attended with leſs ſenſe and leſs imagination from Ariſtotle down to the preſent time; for by the word memory theſe writers only underſtood the unmeaning repetition of words or numbers in the order they were received, without any voluntary efforts of the mind.

In this temperament thoſe aſſociations of motions, which are commonly termed ſympathies, act with greater certainty and energy, as thoſe between diſturbed viſion and the inverſion of the motion of the ſtomach, as in ſea ſickneſs; and the pains in the ſhoulder from hepatic inflammation. Add to this, that the catenated circles of actions are of greater extent than in the other conſtitutions. Thus if a ſtrong vomit or cathartic be exhibited in this temperament, a ſmaller quantity will produce as great an effect, if it be given ſome weeks afterwards; whereas in other temperaments this is only to be expected, if it be exhibited in a few days after the firſt doſe. Hence quartan agues are formed in thoſe of this temperament, as explained in Section XXXII. on diſeaſes from irritation, and other intermittents are liable to recur from ſlight cauſes many weeks after they have been cured by the bark.

V. The firſt of theſe temperaments differs from the ſtandard of health from defect, and the others from exceſs of ſenſorial power; but it ſometimes happens that the ſame individual, from the changes introduced into his habit by the different ſeaſons of the year, modes or periods of life, or by accidental diſeaſes, paſſes from one of theſe temperaments to another. Thus a long uſe of too much fermented liquor produces the temperament of increaſed ſenſibility; great indolence and ſolitude that of decreaſed irritability; and want of the neceſſaries of life that of increaſed voluntarity.

SECT. XXXII.

DISEASES OF IRRITATION.

I. *Irritative fevers with ſtrong pulſe. With weak pulſe. Symptoms of fever. Their ſource.* II. 1. *Quick pulſe is owing to decreaſed irritability.* 2. *Not in ſleep or in apoplexy.* 3. *From inanition. Owing to deficiency of ſenſorial power.* III. 1. *Cauſes of fever. From defect of heat. Heat from ſecretions. Pain of cold in the loins and forehead.* 2. *Great expenſe of ſenſorial power in the vital motions. Immerſion in cold water. Succeeding glow of heat. Difficult reſpiration in cold bathing explained. Why the cold bath invigorates. Bracing and relaxation are mechanical terms.* 3. *Uſes of cold bathing. Uſes of cold air in fevers.* 4. *Ague fits from cold air. Whence their periodical returns.* IV. *Defect of diſtention a cauſe of fever. Deficiency of blood. Transfuſion of blood.* V. 1. *Defect of momentum of the blood from mechanic ſtimuli.* 2. *Air injected into the blood-veſſels.* 3. *Exerciſe increaſes the momentum of the blood.* 4. *Sometimes bleeding increaſes the momentum of it.* VI. *Influence of the ſun and moon on diſeaſes. The chemical ſtimulus of the blood. Menſtruation obeys the lunations. Queries.* VII. *Quieſcence of large glands a cauſe of fever. Swelling of the præcordia.* VIII. *Other cauſes of quieſcence, as hunger, bad air, fear, anxiety.* IX. 1. *Symptoms of the cold fit.* 2. *Of the hot fit.* 3. *Second cold fit why.* 4. *Inflammation introduced, or delirium, or ſtupor.* X. *Recapitulation. Fever not an effort of nature to relieve herſelf. Doctrine of ſpaſm.*

I. When the contractile ſides of the heart and arteries perform a greater number of pulſations in a given time, and move through a greater area at each pulſation, whether theſe motions are occaſioned by the ſtimulus of the acrimony or quantity of the blood, or by their aſſociation with other irritative motions, or by the increaſed irritability of the arterial ſyſtem, that is, by an increaſed quantity of ſenſorial power, one kind of fever is produced; which may be called Synocha irritativa, or Febris irritativa pulſu forti, or irritative fever with ſtrong pulſe.

When the contractile ſides of the heart and arteries perform a greater number of pulſations in a given time, but move through a much leſs area at each pulſation, whether theſe motions are occaſioned by defect of their natural ſtimuli, or by the defect of other irritative motions with which they are aſſociated, or from the inirritability of the arterial ſyſtem, that is, from a decreaſed quantity of ſenſorial power, another kind of fever ariſes; which may be termed, Typhus irritativus, or Febris irritativa pulſu debili, or irritative fever with weak pulſe. The former of theſe fevers is the ſynocha of noſologiſts, and the latter the typhus mitior, or nervous fever. In the former there appears to be an increaſe of ſenſorial power, in the latter a deficiency of it; which is ſhewn to be the immediate cauſe of ſtrength and weakneſs, as defined in Sect. XII. 1. 3.

It ſhould be added, that a temporary quantity of ſtrength or debility may be induced by the defect or exceſs of ſtimulus above what is natural; and that in the ſame fever *debility always exiſts during the cold fit, though ſtrength does not always exiſt during the hot fit.*

Theſe fevers are always connected with, and generally induced by, the diſordered irritative motions of the organs of ſenſe, or of the inteſtinal canal, or of the glandular ſyſtem, or of the abſorbent ſyſtem; and hence are always complicated with ſome or many of theſe diſordered motions, which are termed the ſymptoms of the fever, and which compoſe the great variety in theſe diſeaſes.

The irritative fevers both with ſtrong and with weak pulſe, as well as the ſenſitive fevers with ſtrong and with weak pulſe, which are to be deſcribed in the next ſection, are liable to periodical remiſſions, and then they take the name of intermittent fevers, and are diſtinguiſhed by the periodical times of their acceſs.

II. For the better illuſtration of the phenomena of irritative fevers we muſt refer the reader to the circumſtances of irritation explained in Sect. XII. and ſhall commence this intricate ſubject by ſpeaking of the quick pulſe, and proceed by conſidering many of the cauſes, which either ſeparately or in combination moſt frequently produce the cold fits of fevers.

1. If the arteries are dilated but to half their uſual diameters, though they contract twice as frequently in a given time, they will circulate only half their uſual quantity of blood: for as they are cylinders, the blood which they contain muſt be as the ſquares of their diameters. Hence when the pulſe becomes quicker and ſmaller in the ſame proportion, the heart and arteries act with leſs energy than in their natural ſtate. See Sect. XII. 1. 4.

That this quick ſmall pulſe is owing to want of irritability, appears, firſt, becauſe it attends other ſymptoms of want of irritability; and, ſecondly, becauſe on the application of a ſtimulus greater than uſual, it becomes ſlower and larger. Thus in cold fits of agues, in hyſteric palpitations of the heart, and when the body is much exhauſted by hæmorrhages, or by fatigue, as well as in nervous fevers, the pulſe becomes quick and ſmall; and ſecondly, in all thoſe caſes if an increaſe of ſtimulus be added, by giving a little wine or opium; the quick ſmall pulſe becomes ſlower and larger, as any one may eaſily experience on himſelf, by counting his pulſe after drinking one or two glaſſes of wine, when he is faint from hunger or fatigue.

Now nothing can ſo ſtrongly evince that this quick ſmall pulſe is owing to defect of irritability, as that an additional ſtimulus, above what is natural, makes it become ſlower and larger immediately: for what is meant by a defect of irritability, but that the arteries and heart are not excited into their uſual exertions by their uſual quantity of ſtimulus? but if you increaſe the quantity of ſtimulus, and they immediately act with their uſual energy, this proves their previous want of their natural degree of irritability. Thus the trembling hands of drunkards in a morning become ſteady, and acquire ſtrength to perform their uſual offices, by the accuſtomed ſtimulus of a glaſs or two of brandy.

2. In ſleep and in apoplexy the pulſe becomes ſlower, which is not owing to defect of irritability, for it is at the ſame time larger; and thence the quantity of the circulation is rather increaſed than diminiſhed. In theſe caſes the organs of ſenſe are cloſed, and the voluntary power is ſuſpended, while the motions dependent on internal irritations, as thoſe of digeſtion and ſecretion, are carried on with more than their uſual vigour; which has led ſuperficial obſervers to confound theſe caſes with thoſe ariſing from want of irritability. Thus if you lift up the eyelid of an apoplectic patient, who is not actually dying, the iris will, as uſual, contract itſelf, as this motion is aſſociated with the ſtimulus of light; but it is not ſo in the laſt ſtages of nervous fevers, where

the pupil of the eye continues expanded in the broad day-light: in the former caſe there is a want of voluntary power, in the latter a want of irritability.

Hence alſo thoſe conſtitutions which are deficient in quantity of irritability, and which poſſeſs too great ſenſibility, as during the pain of hunger, of hyſteric ſpaſms, or nervous headaehs, are generally ſuppoſed to have too much irritability; and opium, which in its due doſe is a moſt powerful ſtimulant, is erroneouſly called a ſedative; becauſe by increaſing the irritative motions it decreaſes the pains ariſing from defect of them.

Why the pulſe ſhould become quicker both from an increaſe of irritation, as in the ſynocha irritativa, or irritative fever with ſtrong pulſe; and from the decreaſe of it, as in the typhus irritativus, or irritative fever with weak pulſe; ſeems paradoxical. The former circumſtance needs no illuſtration; ſince if the ſtimulus of the blood, or the irritability of the ſanguiferous ſyſtem be increaſed, and the ſtrength of the patient not diminiſhed, it is plain that the motions muſt be performed quicker and ſtronger.

In the latter circumſtance the weakneſs of the muſcular power of the heart is ſoon over-balanced by the elaſticity of the coats of the arteries, which they poſſeſs beſides a muſcular power of contraction; and hence the arteries are diſtended to leſs than their uſual diameters. The heart being thus ſtopped, when it is but half emptied, begins ſooner to dilate again; and the arteries being dilated to leſs than their uſual diameters, begin ſo much ſooner to contract themſelves; inſomuch, that in the laſt ſtages of fevers with weakneſs the frequency of pulſation of the heart and arteries becomes doubled; which, however, is never the caſe in fevers with ſtrength, in which they ſeldom exceed 118 or 120 pulſations in a minute. It muſt be added, that in theſe caſes, while the pulſe is very ſmall and very quick, the heart often feels large, and labouring to one's hand; which coincides with the above explanation, ſhewing that it does not completely empty itſelf.

3. In caſes however of debility from paucity of blood, as in animals which are bleeding to death in the ſlaughter-houſe, the quick pulſations of the heart and arteries may be owing to their not being diſtended to more than half their uſual diaſtole; and in conſequence they muſt contract ſooner, or more frequently, in a given time. As weak people are liable to a deficient quantity of blood, this cauſe may occaſionally contribute to quicken the pulſe in fevers with debility, which may be known by applying one's hand upon the heart as above; but the principal cauſe I ſuppoſe to conſiſt in the diminution of ſenſorial power. When a muſcle contains, or

is ſupplied with but little ſenſorial power, its contraction ſoon ceaſes, and in conſequence may ſoon recur, as is ſeen in the trembling hands of people weakened by age or by drunkenneſs. See Sect. XII. 1. 4. XII. 3. 4.

It may nevertheleſs frequently happen, that both the deficiency of ſtimulus, as where the quantity of blood is leſſened (as deſcribed in No. 4. of this ſection), and the deficiency of ſenſorial power, as in thoſe of the temperament of inirritability, deſcribed in Sect. XXXI. occur at the ſame time; which will thus add to the quickneſs of the pulſe and to the danger of the diſeaſe.

III. 1. A certain degree of heat is neceſſary to muſcular motion, and is, in conſequence, eſſential to life. This is obſerved in thoſe animals and inſects which paſs the cold ſeaſon in a torpid ſtate, and which revive on being warmed by the fire. This neceſſary ſtimulus of heat has two ſources; one from the fluid atmoſphere of heat, in which all things are immerſed, and the other from the internal combinations of the particles, which form the various fluids, which are produced in the extenſive ſyſtems of the glands. When either the external heat, which ſurrounds us, or the internal production of it, becomes leſſened to a certain degree, the pain of cold is perceived.

This pain of cold is experienced moſt ſenſibly by our teeth, when ice is held in the mouth; or by our whole ſyſtem after having been previouſly accuſtomed to much warmth. It is probable, that this pain does not ariſe from the mechanical or chemical effects of a deficiency of heat; but that, like the organs of ſenſe by which we perceive hunger and thirſt, this ſenſe of heat ſuffers pain, when the ſtimulus of its object is wanting to excite the irritative motions of the organ; that is, when the ſenſorial power becomes too much accumulated in the quieſcent fibres. See Sect. XII. 5. 3. For as the periſtaltic motions of the ſtomach are leſſened, when the pain of hunger is great, ſo the action of the cutaneous capillaries are leſſened during the pain of cold; as appears by the paleneſs of the ſkin, as explained in Sect. XIV. 6. on the production of ideas.

The pain in the ſmall of the back and forehead in the cold fits of the ague, in nervous hemicrania, and in hyſteric paroxyſms, when all the irritative motions are much impaired, ſeems to ariſe from this cauſe; the veſſels of theſe membranes or muſcles become torpid by their irritative aſſociations with other parts of the body, and thence produce leſs of their accuſtomed ſecretions, and in conſequence leſs heat is evolved, and they experience the pain of cold; which coldneſs may often be felt by the hand applied upon the affected part.

2. The importance of a greater or leſs deduction

tion of heat from the ſyſtem will be more caſy to comprehend, if we firſt conſider the great expenſe of ſenſorial power uſed in carrying on the vital motions; that is, which circulates, abſorbs, ſecretes, aërates, and elaborates the whole maſs of fluids with unceaſing aſſiduity. The ſenſorial power, or ſpirit of animation, uſed in giving perpetual and ſtrong motion to the heart, which overcomes the elaſticity and vis inertiæ of the whole arterial ſyſtem; next the expenſe of ſenſorial power in moving with great force and velocity the innumerable trunks and ramifications of the arterial ſyſtem; the expenſe of ſenſorial power in circulating the whole maſs of blood through the long and intricate intortions of the very fine veſſels, which compoſe the glands and capillaries; then the expenſe of ſenſorial power in the exertions of the abſorbent extremities of all the lacteals, and of all the lymphatics, which open their mouths on the external ſurface of the ſkin, and on the internal ſurfaces of every cell or interſtice of the body; then the expenſe of ſenſorial power in the venous abſorption, by which the blood is received from the capillary veſſels, or glands, where the arterial power ceaſes, and is drunk up, and returned to the heart; next the expenſe of ſenſorial power uſed by the muſcles of reſpiration in their office of perpetually expanding the bronchia, or air-veſſels, of the lungs; and laſtly in the unceaſing periſtaltic motions of the ſtomach and whole ſyſtem of inteſtines, and in all the ſecretions of bile, gaſtric juice, mucus, perſpirable matter, and the various excretions from the ſyſtem. If we conſider the ceaſeleſs expenſe of ſenſorial power thus perpetually employed, it will appear to be much greater in a day than all the voluntary exertions of our muſcles and organs of ſenſe conſume in a week; and all this without any ſenſible fatigue! Now, if but a part of theſe vital motions are impeded, or totally ſtopped for but a ſhort time, we gain an idea, that there muſt be a great accumulation of ſenſorial power; as its production in theſe organs, which are ſubject to perpetual activity, is continued during their quieſcence, and is in conſequence accumulated.

While, on the contrary, where thoſe vital organs act too forcibly by increaſe of ſtimulus without a proportionally-increaſed production of ſenſorial power in the brain, it is evident, that a great deficiency of action, that is torpor, muſt ſoon follow, as in fevers; whereas the locomotive muſcles, which act only by intervals, are neither liable to ſo great accumulation of ſenſorial power during their times of inactivity, nor to ſo great an exhauſtion of it during their times of action.

Thus, on going into a very cold bath, ſuppoſe at 33 degrees of heat on Fahrenheit's ſcale, the action of the ſubcutaneous capillaries, or glands, and of the mouths of the cutaneous abſorbents is diminiſhed, or ceaſes for a time. Hence leſs or no blood paſſes theſe capillaries, and paleneſs ſucceeds. But ſoon after emerging from the bath, a more florid colour and a greater degree of heat are generated on the ſkin than was poſſeſſed before immerſion; for the capillary glands, after this quieſcent ſtate, occaſioned by the want of ſtimulus, become more irritable than uſual to their natural ſtimuli, owing to the accumulation of ſenſorial power, and hence a greater quantity of blood is tranſmitted through them, and a greater ſecretion of perſpirable matter; and, in conſequence, a greater degree of heat ſucceeds. During the continuance in cold water the breath is cold, and the act of reſpiration quick and laborious; which have generally been aſcribed to the obſtruction of the circulating fluid by a ſpaſm of the cutaneous veſſels, and by a conſequent accumulation of blood in the lungs, occaſioned by the preſſure as well as by the coldneſs of the water. This is not a ſatisfactory account of this curious phænomenon, ſince at this time the whole circulation is leſs, as appears from the ſmallneſs of the pulſe and coldneſs of the breath; which ſhew that leſs blood paſſes through the lungs in a given time; the ſame laborious breathing immediately occurs when the paleneſs of the ſkin is produced by fear, where no external cold or preſſure are applied.

The minute veſſels of the bronchia, through which the blood paſſes from the arterial to the venal ſyſtem, and which correſpond with the cutaneous capillaries, have frequently been expoſed to cold air, and become quieſcent along with thoſe of the ſkin; and hence their motions are ſo aſſociated together, that when one is affected either with quieſcence or exertion, the other ſympathizes with it, according to the laws of irritative aſſociation. See Sect. XXVII. 1. on hæmorrhages.

Beſides the quieſcence of the minute veſſels of the lungs, there are many other ſyſtems of veſſels which become torpid from their irritative aſſociations with thoſe of the ſkin, as the abſorbents of the bladder and inteſtines; whence an evacuation of pale urine occurs, when the naked ſkin is expoſed only to the coldneſs of the atmoſphere; and ſprinkling the naked body with cold water is known to remove even pertinacious conſtipation of the bowels. From the quieſcence of ſuch extenſive ſyſtems of veſſels as the glands and capillaries of the ſkin, and the minute veſſels of the lungs, with their various abſorbent ſeries of veſſels, a great accumulation of ſenſorial powers is occaſioned; part of which is again expended in the increaſed exertion of all theſe veſſels, with an univerſal glow of heat in conſequence of this exertion, and the remainder of it adds vigour to both the vital and voluntary exertions of the whole day.

If the activity of the ſubcutaneous veſſels, and of thoſe with which their actions are aſſociated, was too great before cold immerſion, as in the hot days of ſummer, and by that means the ſenſorial power was previouſly diminiſhed, we ſee the cauſe why the cold bath gives ſuch preſent ſtrength; namely, by ſtopping the unneceſſary activity of the ſubcutaneous veſſels, and thus preventing the too great exhauſtion of ſenſorial power; which, in metaphorical language, has been called *bracing* the ſyſtem: which is, however, a mechanical term, only applicable to drums, or muſical ſtrings: as on the contrary the word *relaxation*, when applied to living animal bodies, can only mean too ſmall a quantity of ſtimulus, or too ſmall a quantity of ſenſorial power; as explained in Sect. XII. 1.

3. This experiment of cold bathing preſents us with a ſimple fever-fit; for the pulſe is weak, ſmall, and quick during the cold immerſion; and becomes ſtrong, full, and quick during the ſubſequent glow of heat; till in a few minutes theſe ſymptoms ſubſide, and the temporary fever ceaſes.

In thoſe conſtitutions where the degree of inirritability, or of debility, is greater than natural, the coldneſs and paleneſs of the ſkin with the quick and weak pulſe continue a long time after the patient leaves the bath; and the ſubſequent heat approaches by unequal fluſhings, and he feels himſelf diſordered for many hours. Hence the bathing in a cold ſpring of water, where the heat is but forty-eight degrees on Fahrenheit's thermometer, much diſagrees with thoſe of weak or inirritable habits of body; who poſſeſs ſo little ſenſorial power, that they cannot without injury bear to have it diminiſhed even for a ſhort time; but who can nevertheleſs bear the more temperate coldneſs of Buxton bath, which is about eighty degrees of heat, and which ſtrengthens them, and makes them by habit leſs liable to great quieſcence from ſmall variations of cold; and thence leſs liable to be diſordered by the unavoidable accidents of life. Hence it appears, why people of theſe inirritable conſtitutions, which is another expreſſion for ſenſorial deficiency, are often much injured by bathing in a cold ſpring of water; and why they ſhould continue but a very ſhort time in baths, which are colder than their bodies; and ſhould gradually increaſe both the degree of coldneſs of the water, and the time of their continuance in it, if they would obtain ſalutary effects from cold immerſions. See Sect. XII. 2. 1.

On the other hand, in all caſes where the heat of the external ſurface of the body, or of the internal ſurface of the lungs, is greater than natural, the uſe of expoſure to cool air may be deduced. In fever-fits attended with ſtrength, that is with great quantity of ſenſorial power, it removes the additional ſtimulus of heat from the ſurfaces above mentioned, and thus prevents their exceſs of uſeleſs motion; and in fever-fits attended with debility, that is with a deficiency of the quantity of ſenſorial power, it prevents the great and dangerous waſte of ſenſorial power expended in the unneceſſary increaſe of the actions of the glands and capillaries of the ſkin and lungs.

4. In the ſame manner, when any one is long expoſed to very cold air, a quieſcence is produced of the cutaneous and pulmonary capillaries and abſorbents, owing to the deficiency of their uſual ſtimulus of heat; and this quieſcence of ſo great a quantity of veſſels affects, by irritative aſſociation, the whole abſorbent and glandular ſyſtem, which becomes in a greater or leſs degree quieſcent, and a cold fit of fever is produced.

If the deficiency of the ſtimulus of heat is very great, the quieſcence becomes ſo general as to extinguiſh life, as in thoſe who are frozen to death.

If the deficiency of heat be in leſs degree, but yet ſo great as in ſome meaſure to diſorder the ſyſtem, and ſhould occur the ſucceeding day, it will induce a greater degree of quieſcence than before, from its acting in concurrence with the period of the diurnal circle of actions, explained in Sect. XXXVI. Hence from a ſmall beginning a greater and greater degree of quieſcence may be induced, till a complete fever-fit is formed; and which will continue to recur at the periods by which it was produced. See Sect. XVII. 3. 6.

If the degree of quieſcence occaſioned by defect of the ſtimulus of heat be very great, it will recur a ſecond time by a ſlighter cauſe, than that which firſt induced it. If the cauſe, which induces the ſecond fit of quieſcence, recurs the ſucceeding day, the quotidian fever is produced; if not till the alternate day, the tertian fever; and if not till after ſeventy-two hours from the firſt fit of quieſcence, the quartan fever is formed. This laſt kind of fever recurs leſs frequently than the other, as it is a diſeaſe only of thoſe of the temperament of aſſociability, as mentioned in Sect. XXXI.; for in other conſtitutions the capability of forming a habit ceaſes, before the new cauſe of quieſcence is again applied, if that does not occur ſooner than in ſeventy-two hours.

And hence thoſe fevers, whoſe cauſe is from cold air of the night or morning, are more liable to obſerve the ſolar day in their periods; while thoſe from other cauſes frequently obſerve the lunar day in their periods, their paroxyſms returning near an hour later every day, as explained in Sect. XXXVI.

IV. Another frequent cauſe of the cold fits of fever is the defect of the ſtimulus of diſtention. The whole arterial ſyſtem would appear, by the experiments of Haller, to be irritable by no other ſtimulus, and the motions of the heart and alimentary canal are certainly in ſome meaſure dependent on the ſame cauſe. See Sect. XIV. 7.

Hence there can be no wonder, that the diminution of diſtention ſhould frequently induce the quieſcence, which conſtitutes the beginning of fever-fits.

Monſieur Lieutaud has judiciouſly mentioned the deficiency of the quantity of blood amongſt the cauſes of diſeaſes, which he ſays is frequently evident in diſſections: fevers are hence brought on by great hæmorrhages, diarrhœas, or other evacuations; or from the continued uſe of diet, which contains but little nouriſhment; or from the exhauſtion occaſioned by violent fatigue, or by thoſe chronic diſeaſes in which the digeſtion is much impaired; as where the ſtomach has been long affected with the gout or ſcirrhus; or in the paralyſis of the liver, as deſcribed in Sect. XXX. Hence a paroxyſm of gout is liable to recur on bleeding or purging; as the torpor of ſome viſcus, which precedes the inflammation of the foot, is thus induced by the want of the ſtimulus of diſtention. And hence the extremities of the body, as the noſe and fingers, are more liable to become cold, when we have long abſtained from food; and hence the pulſe is increaſed both in ſtrength and velocity above the natural ſtandard after a full meal by the ſtimulus of diſtention.

However, this ſtimulus of diſtention, like the ſtimulus of heat above deſcribed, though it contributes much to the due action not only of the heart, arteries, and alimentary canal, but ſeems neceſſary to the proper ſecretion of all the various glands; yet perhaps it is not the ſole cauſe of any of theſe numerous motions: for as the lacteals, cutaneous abſorbents, and the various glands appear to be ſtimulated into action by the peculiar pungency of the fluids they abſorb, ſo in the inteſtinal canal the pungency of the digeſting aliment, or the acrimony of the fæces, ſeems to contribute, as well as their bulk, to promote the periſtaltic motions; and in the arterial ſyſtem, the momentum of the particles of the circulating blood, and their acrimony, ſtimulate the arteries, as well as the diſtention occaſioned by it. Where the pulſe is ſmall this defect of diſtention is preſent, and contributes much to produce the febris irritativa pulſu debili, or irritative fever with weak pulſe, called by modern writers nervous fever, as a prediſponent cauſe. See Sect. XII. 1. 4. Might not the transfuſion of blood, ſuppoſe of four ounces daily from a ſtrong man, or other healthful animal, as a ſheep or an aſs, be uſed in the early ſtate of nervous or putrid fevers with great proſpect of ſucceſs?

V. The defect of the momentum of the particles of the circulating blood is another cauſe of the quieſcence, with which the cold fits of fever commence. This ſtimulus of the momentum of the progreſſive particles of the blood does not act over the whole body like thoſe of heat and diſtention above deſcribed, but is confined to the arterial ſyſtem; and differs from the ſtimulus of the diſtention of the blood, as much as the vibration of the air does from the currents of it. Thus are the different organs of our bodies ſtimulated by four different mechanic properties of the external world: the ſenſe of touch by the preſſure of ſolid bodies ſo as to diſtinguiſh their figure; the muſcular ſyſtem by the diſtention, which they occaſion; the internal ſurface of the arteries, by the momentum of their moving particles; and the auditory nerves, by the vibration of them: and theſe four mechanic properties are as different from each other as the various chemical ones, which are adapted to the numerous glands, and to the other organs of ſenſe.

2. The momentum of the progreſſive particles of blood is compounded of their velocity and their quantity of matter: hence whatever circumſtances diminiſh either of theſe without proportionally increaſing the other, and without ſuperadding either of the general ſtimuli of heat or diſtention, will tend to produce a quieſcence of the arterial ſyſtem, and from thence of all the other irritative motions, which are connected with it.

Hence in all thoſe conſtitutions or diſeaſes where the blood contains a greater proportion of ſerum, which is the lighteſt part of its compoſition, the pulſations of the arteries are weaker, as in nervous fevers, chloroſis, and hyſteric complaints; for in theſe caſes the momentum of the progreſſive particles of blood is leſs; and hence, where the denſer parts of its compoſition abound, as the red part of it, or the coagulable lymph, the arterial pulſations are ſtronger; as in thoſe of robuſt health, and in inflammatory diſeaſes.

That this ſtimulus of the momentum of the particles of the circulating fluid is of the greateſt conſequence to the arterial action, appears from the experiment of injecting air into the blood veſſels, which ſeems to deſtroy animal life from the want of this ſtimulus of momentum; for the diſtention of the arteries is not diminiſhed by it, it poſſeſſes no corroſive acrimony, and is leſs liable to repaſs the valves than the blood itſelf; ſince air-valves in all machinery require much leſs accuracy of conſtruction than thoſe which are oppoſed to water.

3. One method of increaſing the velocity of the blood, and in conſequence the momentum of its particles, is by the exerciſe of the body, or by the friction of its ſurface; ſo, on the contrary, too great indolence contributes to decreaſe this ſtimulus of the momentum of the particles of the circulating blood, and thus tends to induce quieſcence; as is ſeen in hyſteric caſes, and chloroſis, and the other diſeaſes of ſedentary people.

4. The velocity of the particles of the blood in

certain circumſtances is increaſed by veneſection, which, by removing a part of it, diminiſhes the reſiſtance to the motion of the other part, and hence the momentum of the particles of it is increaſed. This may be eaſily underſtood by conſidering it in the extreme, ſince, if the reſiſtance was greatly increaſed, ſo as to overcome the propelling power, there could be no velocity, and in conſequence no momentum at all. From this circumſtance ariſes that curious phænomenon, the truth of which I have been more than once witneſs to, that veneſection will often inſtantaneouſly relieve thoſe nervous pains, which attend the cold periods of hyſteric, aſthmatic, or epileptic diſeaſes; and that even where large doſes of opium have been in vain exhibited. In theſe caſes the pulſe becomes ſtronger after the bleeding, and the extremities regain their natural warmth; and an opiate then given acts with much more certain effect.

VI. There is another cauſe, which ſeems occaſionally to induce quieſcence into ſome part of our ſyſtem, I mean the influence of the ſun and moon; the attraction of theſe luminaries, by decreaſing the gravity of the particles of the blood, cannot affect their momentum, as their vis inertiæ remains the ſame; but it may nevertheleſs produce ſome chemical change in them, becauſe whatever affects the general attractions of the particles of matter may be ſuppoſed from analogy to affect their ſpecific attractions or affinities: and thus the ſtimulus of the particles of blood may be diminiſhed, though not their momentum. As the tides of the ſea obey the ſouthing and northing of the moon (allowing for the time neceſſary for their motion, and the obſtructions of the ſhores), it is probable, that there are alſo atmoſpheric tides on both ſides of the earth, which to the inhabitants of another planet might ſo deflect the light as to reſemble the ring of Saturn. Now as theſe tides of water, or of air, are raiſed by the diminution of their gravity, it follows, that their preſſure on the ſurface of the earth is no greater than the preſſure of the other parts of the ocean, or of the atmoſphere, where no ſuch tides exiſt; and therefore that they cannot affect the mercury in the barometer. In the ſame manner, the gravity of all other terreſtrial bodies is diminiſhed at the times of the ſouthing and northing of the moon, and that in a greater degree when this coincides with the ſouthing and northing of the ſun, and this in a ſtill greater degree about the times of the equinoxes. This decreaſe of the gravity of all bodies during the time the moon paſſes our zenith or nadir might poſſibly be ſhewn by the ſlower vibrations of a pendulum, compared with a ſpring clock, or with aſtronomical obſervation. Since a pendulum of a certain length moves ſlower at the line than near the poles, becauſe the gravity being diminiſhed and the vis inertiæ continuing the ſame, the motive power is leſs, but the reſiſtance to be overcome continues the ſame. The combined powers of the lunar and ſolar attraction are eſtimated by Sir Iſaac Newton not to exceed one 7,868,850th part of the power of gravitation, which ſeems indeed but a ſmall circumſtance to produce any conſiderable effect on the weight of ſublunary bodies, and yet this is ſufficient to raiſe the tides at the equator above ten feet high; and if it be conſidered, what ſmall impulſes of other bodies produce their effects on the organs of ſenſe adapted to the perception of them, as of vibration on the auditory nerves, we ſhall ceaſe to be ſurpriſed, that ſo minute a diminution in the gravity of the particles of blood ſhould ſo far affect their chemical changes, or their ſtimulating quality, as, joined with other cauſes, ſometimes to produce the beginnings of diſeaſes.

Add to this, that if the lunar influence produces a very ſmall degree of quieſcence at firſt, and if that recurs at certain periods even with leſs power to produce quieſcence than at firſt, yet the quieſcence will daily increaſe by the acquired habit acting at the ſame time, till at length ſo great a degree of quieſcence is induced as to produce phrenſy, canine madneſs, epilepſy, hyſteric pains or cold fits of fever, inſtances of many of which are to be found in Dr. Mead's work on this ſubject. The ſolar influence alſo appears daily in ſeveral diſeaſes; but as darkneſs, ſilence, ſleep, and our periodical meals mark the parts of the ſolar circle of actions, it is ſometimes dubious to which of theſe the periodical returns of theſe diſeaſes are to be aſcribed.

As far as I have been able to obſerve, the periods of inflammatory diſeaſes obſerve the ſolar day; as the gout and rheumatiſm have their greateſt quieſcence about noon and midnight, and their exacerbations ſome hours after; as they have more frequently their immediate cauſe from cold air, inanition, or fatigue, than from the effects of lunations: whilſt the cold fits of hyſteric patients, and thoſe in nervous fevers, more frequently occur twice a day, later by near half an hour each time, according to the lunar day; whilſt ſome fits of intermittents, which are undiſturbed by medicines, return at regular ſolar periods, and others at lunar ones; which may, probably, be owing to the difference of the periods of thoſe external circumſtances of cold, inanition, or lunation, which immediately cauſed them.

We muſt, however, obſerve, that the periods of quieſcence and exacerbation in diſeaſes do not always commence at the times of the ſyzygies or quadratures of the moon and ſun, or at the times of their paſſing the zenith or nadir; but as it is probable, that the ſtimulus of the particles of the circumfluent blood is gradually diminiſhed from the time of the quadratures to that of the ſyzygies, the quieſcence may commence at any hour, when co-operating with other cauſes of quieſcence, it becomes great enough to produce a diſeaſe: afterwards it will continue to recur at the ſame period of the lunar or ſolar influence; the ſame cauſe operating conjointly with the acquired habit, that is with the catenation of this new motion with the diſſevered links of the lunar or ſolar circles of animal action.

In this manner the periods of menſtruation obey the lunar month with great exactneſs in healthy patients (and perhaps the venereal orgaſm in brute animals does the ſame), yet theſe periods do not commence either at the ſyzygies or quadratures of the lunations, but at whatever time of the lunar periods they begin, they obſerve the ſame in their returns till ſome greater cauſe diſturbs them.

Hence, though the beſt way to calculate the time of the expected returns of the paroxyſms of periodical diſeaſes is to count the number of hours between the commencement of the two preceding fits, yet the following obſervations may be worth attending to, when we endeavour to prevent the returns of maniacal or epileptic diſeaſes; whoſe periods (at the beginning of them eſpecially) frequently obſerve the ſyzygies of the moon and ſun, and particularly about the equinox.

The greateſt of the two tides happening in every revolution of the moon, is that when the moon approaches neareſt to the zenith or nadir; for this reaſon, while the ſun is in the northern ſigns, that is during the vernal and ſummer months, the greater of the two diurnal tides in our latitude is that, when the moon is above the horizon; and when the ſun is in the ſouthern ſigns, or during the autumnal and winter months, the greater tide is that, which ariſes when the moon is below the horizon; and as the ſun approaches ſomewhat nearer the earth in winter than in ſummer, the greateſt equinoctial tides are obſerved to be a little before the vernal equinox, and a little after the autumnal one.

Do not the cold periods of lunar diſeaſes commence a few hours before the ſouthing of the moon during the vernal and ſummer months, and before the northing of the moon during the autumnal and winter months? Do not palſies and apoplexies, which occur about the equinoxes, happen a few days before the vernal equinoctial lunation, and after the autumnal one? Are not the periods of thoſe diurnal diſeaſes more obſtinate, that commence many hours before the ſouthing or northing of the moon, than of thoſe which commence at thoſe times? Are not thoſe palſies and apoplexies more dangerous which commence many days before the ſyzygies of the moon, than thoſe which happen at thoſe times? See Sect. XXXVI. on the periods of diſeaſes.

VII. Another very frequent cauſe of the cold fit of fever is the quieſcence of ſome of thoſe large congeries of glands, which compoſe the liver, ſpleen, or pancreas; one or more of which are frequently ſo enlarged in the autumnal intermittents as to be perceptible to the touch externally, and are called by the vulgar ague-cakes. As theſe glands are ſtimulated into action by the ſpecific pungency of the fluids, which they abſorb, the general cauſe of their quieſcence ſeems to be too great inſipidity of the fluids of the body, co-operating perhaps at the ſame time with other general cauſes of quieſcence.

Hence, in marſhy countries at cold ſeaſons, which have ſucceeded hot ones, and amongſt thoſe, who have lived on innutritious and unſtimulating diet, theſe agues are moſt frequent. The enlargement of theſe quieſcent viſcera, and the ſwelling of the præcordia in many other fevers, is, moſt probably, owing to the ſame cauſe; which may conſiſt in a general deficiency of the production of ſenſorial power, as well as in the diminiſhed ſtimulation of the fluids; and when the quieſcence of ſo great a number of glands, as conſtitute one of thoſe large viſcera, commences, all the other irritative motions are affected by their connection with it, and the cold fit of fever is produced.

VIII. There are many other cauſes, which produce quieſcence of ſome part of the animal ſyſtem, as fatigue, hunger, thirſt, bad diet, diſappointed love, unwholeſome air, exhauſtion from evacuations, and many others; but the laſt cauſe, that we ſhall mention, as frequently productive of cold fits of fever, is fear or anxiety of mind. The pains, which we are firſt and moſt generally acquainted with, have been produced by defect of ſome ſtimulus; thus, ſoon after our nativity we become acquainted with the pain from the coldneſs of the air, from the want of reſpiration, and from the want of food. Now all theſe pains occaſioned by defect of ſtimulus are attended with quieſcence of the organ, and at the ſame time with a greater or leſs degree of quieſcence of other parts of the ſyſtem: thus, if we even endure the pain of hunger ſo as to miſs one meal inſtead of our daily habit of repletion, not only the periſtaltic motions of the ſtomach and bowels are diminiſhed, but we are more liable to coldneſs of our extremities, as of our noſes, and ears, and feet, than at other times.

Now, as fear is originally excited by our having experienced pain, and is itſelf a painful affection, the ſame quieſcence of other fibrous motions accompanies it, as has been moſt frequently connected with this kind of pain, as explained in Sect. XVI. 8. 1. as the coldneſs and paleneſs of the ſkin, trembling, difficult reſpiration, indigeſtion, and other ſymptoms, which contribute to form the cold fit of fevers. Anxiety is fear continued through a longer time, and, by producing chronical torpor of the ſyſtem, extinguiſhes life ſlowly, by what is commonly termed a broken heart.

IX. 1. We now ſtep forwards to conſider the other ſymptoms in conſequence of the quieſcence which begins the fits of fever. If by any of the circumſtances before deſcribed, or by two or more of them acting at the ſame time, a great degree of quieſcence is induced on any conſiderable part of the circle of irritative motions, the whole claſs of them is more or leſs diſturbed by their irritative aſſociations. If this torpor be occaſioned by a deficient ſupply of ſenſorial power, and happens to any of thoſe parts of the ſyſtem, which are accuſtomed to perpetual activity, as the vital motions, the torpor increaſes rapidly, becauſe of the great expenditure of ſenſorial power by the inceſſant activity of thoſe parts of the ſyſtem, as ſhewn in No. 3. 2. of this Section. Hence a deficiency of all the ſecretions ſucceeds, and as animal heat is produced in proportion to the quantity of thoſe ſecretions, the coldneſs of the ſkin is the firſt circumſtance, which is attended to. Dr. Martin aſſerts, that ſome parts of his body were warmer than natural in the cold fit of fever; but it is certain, that thoſe, which are uncovered, as the fingers, and noſe, and ears, are much colder to the touch, and paler in appearance. It is poſſible, that his experiments were made at the beginning of the ſubſequent hot fits; which commence with partial diſtributions of heat, owing to ſome parts of the body regaining their natural irritability ſooner than others.

From the quieſcence of the anaſtomoſing capillaries a paleneſs of the ſkin ſucceeds, and a leſs ſecretion of the perſpirable matter; from the quieſcence of the pulmonary capillaries a difficulty of reſpiration ariſes; and from the quieſcence of the other glands leſs bile, leſs gaſtric and pancreatic juice, are ſecreted into the ſtomach and inteſtines, and leſs mucus and ſaliva are poured into the mouth; whence ariſes the dry tongue, coſtiveneſs, dry ulcers, and paucity of urine. From the quieſcence of the abſorbent ſyſtem ariſes the great thirſt, as leſs moiſture is abſorbed from the atmoſphere. The abſorption from the atmoſphere was obſerved by Dr. Liſter to amount to eighteen ounces in one night, above what he had at the ſame time inſenſibly perſpired. See Langriſh. On the ſame account the urine is pale, though in ſmall quantity, for the thinner part is not abſorbed from it; and when repeated ague-fits continue long, the legs ſwell from the diminiſhed abſorption of the cellular abſorbents.

From the quieſcence of the inteſtinal canal a loſs of appetite and flatulencies proceed. From the partial quieſcence of the glandular viſcera a ſwelling and tenſion about the præcordia become ſenſible to the touch; which are occaſioned by the delay of the fluids from the defect of venous or lymphatic abſorption. The pain of the forehead, and of the limbs, and of the ſmall of the back, ariſes from the quieſcence of the membranous faſcia, or muſcles of thoſe parts, in the ſame manner as the ſkin becomes painful, when the veſſels, of which it is compoſed, become quieſcent from cold. The trembling in conſequence of the pain of coldneſs, the reſtleſſneſs, and the yawning, and ſtretching of the limbs, together with the ſhuddering, or rigors, are convulſive motions; and will be explained amongſt the diſeaſes of volition; Sect. XXXIV.

Sickneſs and vomiting are a frequent ſymptom in the beginnings of fever-fits, the muſcular fibres of the ſtomach ſhare the general torpor and debility of the ſyſtem; their motions become firſt leſſened, and ſtop, and then become retrograde; for the act of vomiting, like the globus hyſtericus and the borborigmi of hypochondriaſis, is always a ſymptom of debility, either from want of ſtimulus, as in hunger; or from want of ſenſorial power, as after intoxication; or from ſympathy with ſome other torpid irritative motions, as in the cold fits of ague. See Sect. XII. 5. 5. XXIX. 11. and XXXV. 1. 3.

1. 3. where this act of vomiting is further explained.

The ſmall pulſe, which is ſaid by ſome writers to be ſlow at the commencement of ague-fits, and which is frequently trembling and intermittent, is owing to the quieſcence of the heart and arterial ſyſtem, and to the reſiſtance oppoſed to the circulating fluid from the inactivity of all the glands and capillaries. The great weakneſs and inability to voluntary motions, with the inſenſibility of the extremities, are owing to the general quieſcence of the whole moving ſyſtem; or, perhaps, ſimply to the deficient production of ſenſorial power.

If all theſe ſymptoms are further increaſed, the quieſcence of all the muſcles, including the heart and arteries, becomes complete, and death enſues. This is, moſt probably, the caſe of thoſe who are ſtarved to death with cold, and of thoſe who are ſaid to die in Holland from long ſkaiting on their frozen canals.

2. As ſoon as this general quieſcence of the ſyſtem ceaſes, either by the diminution of the cauſe, or by the accumulation of ſenſorial power, (as in ſyncope, Sect. XII. 7. 1.) which is the natural conſequence of previous quieſcence, the hot fit commences. Every gland of the body is now ſtimulated into ſtronger action than is natural, as its irritability is increaſed by accumulation of ſenſorial power during its late quieſcence, a ſuper-

a ſuperabundance of all the ſecretions is produced, and an increaſe of heat in conſequence of the increaſe of theſe ſecretions. The ſkin becomes red, and the perſpiration great, owing to the increaſed action of the capillaries during the hot part of the paroxyſm. The ſecretion of perſpirable matter is perhaps greater during the hot fit than in the ſweating fit which follows; but as the abſorption of it alſo is greater, it does not ſtand on the ſkin in viſible drops: add to this, that the evaporation of it alſo is greater, from the increaſed heat of the ſkin. But at the decline of the hot fit, as the mouths of the abſorbents of the ſkin are expoſed to the cooler air, or bed clothes, theſe veſſels ſooner loſe their increaſed activity, and ceaſe to abſorb more than their natural quantity: but the ſecerning veſſels for ſome time longer, being kept warm by the circulating blood, continue to pour out an increaſed quantity of perſpirable matter, which now ſtands on the ſkin in large viſible drops; the exhalation of it alſo being leſſened by the greater coolneſs of the ſkin, as well as its abſorption by the diminiſhed action of the lymphatics. See Claſs I. 1. 2. 3.

The increaſed ſecretion of bile and of other fluids poured into the inteſtines frequently induces a purging at the decline of the hot fit: for as the external abſorbent veſſels have their mouths expoſed to the cold air, as above mentioned, they ceaſe to be excited into unnatural activity ſooner than the ſecretory veſſels, whoſe mouths are expoſed to the warmth of the blood: now, as the internal abſorbents ſympathize with the external ones, theſe alſo, which during the hot fit drank up the thinner part of the bile, or of other ſecreted fluids, loſe their increaſed activity before the gland loſes its increaſed activity, at the decline of the hot fit; and the looſe dejections are produced from the ſame cauſe, that the increaſed perſpiration ſtands on the ſurface of the ſkin, from the increaſed abſorption ceaſing ſooner than the increaſed ſecretion.

The urine during the cold fit is in ſmall quantity and pale, both from a deficiency of the ſecretion and a deficiency of the abſorption. During the hot fit it is in its uſual quantity, but very high coloured and turbid, becauſe a greater quantity had been ſecreted by the increaſed action of the kidneys, and alſo a greater quantity of its more aqueous part had been abſorbed from it in the bladder by the increaſed action of the abſorbents; and laſtly, at the decline of the hot fit it is in large quantity and leſs coloured, or turbid, becauſe the abſorbent veſſels of the bladder, as obſerved above, loſe their increaſed action by ſympathy with the cutaneous ones ſooner than the ſecretory veſſels of the kidneys loſe their increaſed activity. Hence the quantity of the ſediment, and the colour of the urine, in fevers, depend much on the quantity ſecreted by the kidneys, and the quantity abſorbed from it again in the bladder: the kinds of ſediment, as the lateritious, purulent, mucous, or bloody ſediments, depend on other cauſes. It ſhould be obſerved, that if the ſweating be increaſed by the heat of the room, or of the bedclothes, a paucity of turbid urine will continue to be produced, as the abſorbents of the bladder will have their activity increaſed by their ſympathy with the veſſels of the ſkin, for the purpoſe of ſupplying the fluid expended in perſpiration.

The pulſe becomes ſtrong and full owing to the increaſed irritability of the heart and arteries, from the accumulation of ſenſorial power during their quieſcence, and to the quickneſs of the return of the blood from the various glands and capillaries. This increaſed action of all the ſecretory veſſels does not occur very ſuddenly, nor univerſally at the ſame time. The heat ſeems to begin about the centre, and to be diffuſed from thence irregularly to the other parts of the ſyſtem. This may be owing to the ſituation of the parts which firſt became quieſcent and cauſed the fever-fit, eſpecially when a hardneſs or tumour about the præcordia can be felt by the hand; and hence this part, in whatever viſcus it is ſeated, might be the firſt to regain its natural or increaſed irritability.

3. It muſt be here noted, that, by the increaſed quantity of heat, and of the impulſe of the blood at the commencement of the hot fit, a great increaſe of ſtimulus is induced, and is now added to the increaſed irritability of the ſyſtem, which

was occaſioned by its previous quieſcence. This additional ſtimulus of heat and momentum of the blood augments the violence of the movements of the arterial and glandular ſyſtem in an increaſing ratio. Theſe violent exertions ſtill producing more heat and greater momentum of the moving fluids, till at length the ſenſorial power becomes waſted by this great ſtimulus beneath its natural quantity, and prediſpoſes the ſyſtem to a ſecond cold fit.

At length all theſe unnatural exertions ſpontaneouſly ſubſide with the increaſed irritability that produced them; and which was itſelf produced by the preceding quieſcence, in the ſame manner as the eye, on coming from darkneſs into daylight, in a little time ceaſes to be dazzled and pained, and gradually recovers its natural degree of irritability.

4. But if the increaſe of irritability, and the conſequent increaſe of the ſtimulus of heat and momentum, produce more violent exertions than thoſe above deſcribed; great pain ariſes in ſome part of the moving ſyſtem, as in the membranes of the brain, pleura, or joints; and new motions of the veſſels are produced in conſequence of this pain, which are called inflammation; or delirium or ſtupor ariſes; as explained in Sect. XXI. and XXXIII.: for the immediate effect is the ſame, whether the great energy of the moving organs ariſes from an increaſe of ſtimulus or an

increaſe of irritability; though in the former caſe the waſte of ſenſorial power leads to debility, and in the latter to health.

Recapitulation.

X. Thoſe muſcles, which are leſs frequently exerted, and whoſe actions are interrupted by ſleep, acquire leſs accumulation of ſenſorial power during their quieſcent ſtate, as the muſcles of locomotion. In theſe muſcles after great exertion, that is, after great exhauſtion of the ſenſorial power, the pain of fatigue enſues; and during reſt there is a renovation of the natural quantity of ſenſorial power; but where the reſt, or quieſcence of the muſcle, is long continued, a quantity of ſenſorial power becomes accumulated beyond what is neceſſary; as appears by the uneaſineſs occaſioned by want of exerciſe; and which in young animals is one cauſe exciting them into action, as is ſeen in the play of puppies and kittens.

But when thoſe muſcles, which are habituated to perpetual actions, as thoſe of the ſtomach by the ſtimulus of food, thoſe of the veſſels of the ſkin by the ſtimulus of heat, and thoſe which conſtitute the arteries and glands by the ſtimulus of the blood, become for a time quieſcent, from the want of their appropriated ſtimuli, or by their aſſociations with other quieſcent parts of the ſyſtem; a greater accumulation of ſenſorial power is acquired during their quieſcence, and a greater or quicker exhauſtion of it is produced during their increaſed action.

This accumulation of ſenſorial power from deficient action, if it happens to the ſtomach from want of food, occaſions the pain of hunger; if it happens to the veſſels of the ſkin from want of heat, it occaſions the pain of cold; and if to the arterial ſyſtem from the want of its adapted ſtimuli, many diſagreeable ſenſations are occaſioned, ſuch as are experienced in the cold fits of intermittent fevers, and are as various, as there are glands or membranes in the ſyſtem, and are generally termed univerſal uneaſineſs.

When the quieſcence of the arterial ſyſtem is not owing to defect of ſtimulus as above, but to the defective quantity of ſenſorial power, as in the commencement of nervous fever, or irritative fever with weak pulſe, a great torpor of this ſyſtem is quickly induced; becauſe both the irritation from the ſtimulus of the blood, and the aſſociation of the vaſcular motions with each other, continue to excite the arteries into action, and thence quickly exhauſt the ill-ſupplied vaſcular muſcles; for to reſt is death; and therefore thoſe vaſcular muſcles continue to proceed, though with feebler action, to the extreme of wearineſs or faintneſs: while nothing ſimilar to this affects the locomotive muſcles, whoſe actions are generally cauſed by volition, and not much ſubject either to irritation or to other kinds of aſſociations beſides the voluntary ones, except indeed when they are excited by the laſh of ſlavery.

In theſe vaſcular muſcles, which are ſubject to perpetual action, and thence liable to great accumulation of ſenſorial power during their quieſcence from want of ſtimulus, a great increaſe of activity occurs, either from the renewal of their accuſtomed ſtimulus, or even from much leſs quantities of ſtimulus than uſual. This increaſe of action conſtitutes the hot fit of fever, which is attended with various increaſed ſecretions, with great concomitant heat, and general uneaſineſs. The uneaſineſs attending this hot paroxyſm of fever, or fit of exertion, is very different from that, which attends the previous cold fit, or fit of quieſcence, and is frequently the cauſe of inflammation, as in pleuriſy, which is treated of in the next ſection.

A ſimilar effect occurs after the quieſcence of our organs of ſenſe; thoſe which are not ſubject to perpetual action, as the taſte and ſmell, are leſs liable to an exuberant accumulation of ſenſorial power after their having for a time been inactive; but the eye, which is in perpetual action during the day, becomes dazzled, and liable to inflammation after a temporary quieſcence.

Where the previous quieſcence has been owing to a defect of ſenſorial power, and not to a defect of ſtimulus, as in the irritative fever with weak pulſe, a ſimilar increaſe of activity of the arterial ſyſtem ſucceeds, either from the uſual ſtimulus of the blood, or from a ſtimulus leſs than uſual; but as there is in general in theſe caſes of fever with weak pulſe a deficiency of the quantity of the blood, the pulſe in the hot fit is weaker than in health, though it is ſtronger than in the cold fit, as explained in No. 2. of this ſection. But at the ſame time in thoſe fevers, where the defect of irritation is owing to the defect of the quantity of ſenſorial power, as well as to the defect of ſtimulus, another circumſtance occurs; which conſiſts in the partial diſtribution of it, as appears in partial fluſhings, as of the face or boſom, while the extremities are cold; and in the increaſe of particular ſecretions, as of bile, ſaliva, inſenſible perſpiration, with great heat of the ſkin, or with partial ſweats, or diarrhœa.

There are alſo many uneaſy ſenſations attending theſe increaſed actions, which like thoſe belonging to the hot fit of fever with ſtrong pulſe, are frequently followed by inflammation, as in ſcarlet fever; which inflammation is nevertheleſs accompanied with a pulſe weaker, though quicker, than the pulſe during the remiſſion or intermiſſion of the paroxyſms, though ſtronger than that of the previous cold fit.

From hence I conclude, that both the cold and hot fits of fever are neceſſary conſequences of the perpetual and inceſſant action of the arterial and glandular ſyſtem; ſince thoſe muſcular fibres and thoſe organs of ſenſe, which are moſt frequently exerted, become neceſſarily moſt affected both with defect and accumulation of ſenſorial power: and that hence *fever-fits are not an effort of nature to relieve herſelf*, and that therefore they ſhould always be prevented or diminiſhed as much as poſſible, by any means which decreaſe the general or partial vaſcular actions, when they are greater, or by increaſing them when they are leſs than in health, as deſcribed in Sect. XII. 6. 1.

Thus have I endeavoured to explain, and I hope to the ſatisfaction of the candid and patient reader, the principal ſymptoms or circumſtances of fever without the introduction of the ſupernatural power of ſpaſm. To the arguments in favour of the doctrine of ſpaſm it may be ſufficient to reply, that in the evolution of medical as well as of dramatic cataſtrophe,

> Nec Deus interſit, niſi dignus vindice nodus
> Inciderit. Hor.

XI. 1. Since I printed the above in the firſt edition of this work, I am told, that the ſpaſmodic doctrine of fever has yet its advocates; who believe that the coldneſs at the beginning of intermittent fevers is owing to a ſpaſm of the cutaneous veſſels. But as the ſkin is at that time lax and ſoft, the muſcular fibres of thoſe cutaneous veſſels cannot be in action or contraction, which conſtitute ſpaſm. Whence we have the evidence both of our ſight and touch againſt this wild imagination.

Others have advanced, that this ſpaſmodic contraction of the cutaneous veſſels or pores confines the heat, or drives it to the heart; which in the hot fit of fever repels the heat again to the ſkin by its reaction. Thoſe, who eſpouſe this doctrine, ſeem to conceive, that the particles of heat are as large as ſhot-corns, or as the globules of blood; and not that it is an ethereal fluid, in which all things are immerſed, and by which all things are penetrated; an opinion which originated from Galen, and muſt have been founded on a total ignorance of chemiſtry, and natural philoſophy. Others, I hear, ſtill ſuppoſe cold to be a ſtimulus, not underſtanding that it is ſimply the abſence of heat; and that darkneſs might as well be called a ſtimulus to the eye, or hunger a ſtimulus to the ſtomach, as cold to our ſenſe, which perceives heat; which is commonly confounded with our ſenſe of touch, which perceives figure. The pain, which we experience on being expoſed to a want of heat, which is termed chillneſs, or coldneſs; and the pain we experience in our organs of digeſtion from the want of food, which is termed hunger; both ariſe from the inactivity of thoſe veſſels, which ought to be either perpetually, or at periodical times ſtimulated into action. See Sect. XIII. 3. 2. And the ſhivering or actions of the ſubcutaneous muſcles, when we are cold, are in conſequence of the pain, or voluntary exertion to relieve that pain, and originate from the want of ſtimulus, not from the exceſs of it.

In this age of reaſon it is not the opinions of others, but the natural phænomena, on which thoſe opinions are founded, which deſerve to be canvaſſed. And with the ſuppoſed exiſtence of ghoſts or apparitions, witchcraft, vampyriſm, aſtrology, animal magnetiſm, and American tractors, ſuch theories as the above muſt vaniſh like the ſcenery of a dream; as they conſiſt of ſuch combinations of ideas, as have no prototype or correſpondent combinations of material objects exiſting in nature.

SECT. XXXIII.

DISEASES OF SENSATION.

I. *Motions excited by ſenſation. Digeſtion. Generation. Pleaſure of exiſtence. Hypochondriaciſm.* 2. *Pain introduced. Senſitive fevers of two kinds.* 3. *Two ſenſorial powers exerted in ſenſitive fevers. Size of the blood. Nervous fevers diſtinguiſhed from putrid ones. The ſeptic and antiſeptic theory.* 4. *Two kinds of delirium.* 5. *Other animals are leſs liable to delirium, cannot receive our contagious diſeaſes, and are leſs liable to madneſs.* II. 1. *Senſitive motions generated.* 2. *Inflammation explained.* 3. *Its remote cauſes from exceſs of irritation, or of irritability, not from thoſe pains which are owing to defect of irritation. New veſſels produced, and much heat.* 4. *Purulent matter ſecreted.* 5. *Contagion explained.* 6. *Received but once.* 7. *If common matter be contagious?* 8. *Why ſome contagions are received but once.* 9. *Why others may be received frequently. Contagions of ſmall-pox and meaſles do not act at the ſame time. Two caſes of ſuch patients.* 10. *The blood from patients in the ſmall-pox will not infect others. Caſes of children thus inoculated. The variolous contagion is not received into the blood. It acts by ſenſitive aſſociation between the ſtomach and ſkin.* III. 1. *Abſorption of ſolids and fluids.* 2. *Art of healing ulcers.* 3. *Mortification attended with leſs pain in weak people.*

I. 1. As many motions of the body are excited and continued by irritations, ſo others require,

quire, either conjunctly with theſe, or ſeparately, the pleaſurable or painful ſenſations, for the purpoſe of producing them with due energy. Amongſt theſe the buſineſs of digeſtion ſupplies us with an inſtance: if the food, which we ſwallow, is not attended with agreeable ſenſation, it digeſts leſs perfectly; and if very diſagreeable ſenſation accompanies it, ſuch as a nauſeous idea, or very diſguſtful taſte, the digeſtion becomes impeded; or retrograde motions of the ſtomach and œſophagus ſucceed, and the food is ejected.

The buſineſs of generation depends ſo much on agreeable ſenſation, that, where the object is diſguſtful, neither voluntary exertion nor irritation can effect the purpoſe; which is alſo liable to be interrupted by the pain of fear or baſhfulneſs.

Beſides the pleaſure, which attends the irritations produced by the objects of luſt and hunger, there ſeems to be a ſum of pleaſurable affection accompanying the various ſecretions of the numerous glands, which conſtitute the pleaſure of life, in contradiſtinction to the tedium vitæ. This quantity or ſum of pleaſurable affection ſeems to contribute to the due or energetic performance of the whole moveable ſyſtem, as well that of the heart and arteries, as of digeſtion and of abſorption; ſince without the due quantity of pleaſurable ſenſation, flatulency and hypochondriaciſm affect the inteſtines, and a languor ſeizes the arterial pulſations and ſecretions; as occurs in great and continued anxiety of the mind.

2. Beſides the febrile motions occaſioned by irritation, deſcribed in Sect. XXXII. and termed irritative fever, it frequently happens that pain is excited by the violence of the fibrous contractions; and other new motions are then ſuperadded, in conſequence of ſenſation, which we ſhall term febris ſenſitiva, or ſenſitive fever. It muſt be obſerved, that moſt irritative fevers begin with a decreaſed exertion of irritation, owing to defect of ſtimulus; but that on the contrary the ſenſitive fevers or inflammations, generally begin with the increaſed exertion of ſenſation, as mentioned in Sect. XXXI. on temperaments: for though the cold fit, which introduces inflammation, commences with decreaſed irritation, yet the inflammation itſelf commences in the hot fit during the increaſe of ſenſation. Thus a common puſtule, or phlegmon, in a part of little ſenſibility does not excite an inflammatory fever; but if the ſtomach, inteſtines, or the tender ſubſtance beneath the nails, be injured, great ſenſation is produced, and the whole ſyſtem is thrown into that kind of exertion, which conſtitutes inflammation.

Theſe ſenſitive fevers, like the irritative ones, reſolve themſelves into thoſe with arterial ſtrength, and thoſe with arterial debility, that is with exceſs or defect of ſenſorial power; theſe may be termed the febris ſenſitiva pulſu forti, ſenſitive fever with ſtrong pulſe, which is the ſynocha, or inflammatory fever; and the febris ſenſitiva pulſu debili, ſenſitive fever with weak pulſe, which is the typhus gravior, or putrid fever of ſome writers.

3. The inflammatory fevers, which are here termed ſenſitive fevers with ſtrong pulſe, are generally attended with ſome topical inflammation, as pleuriſy, peripneumony, or rheumatiſm, which diſtinguiſhes them from irritative fevers with ſtrong pulſe. The pulſe is ſtrong, quick, and full; for in this fever there is great irritation, as well as great ſenſation, employed in moving the arterial ſyſtem. The ſize, or coagulable lymph, which appears on the blood, is probably an increaſed ſecretion from the inflamed internal lining of the whole arterial ſyſtem, the thinner part being taken away by the increaſed abſorption of the inflamed lymphatics.

The ſenſitive fevers with weak pulſe, which are termed putrid or malignant fevers, are diſtinguiſhed from irritative fevers with weak pulſe, called nervous fevers, deſcribed in the laſt ſection, as the former conſiſt of inflammation joined with debility, and the latter of debility alone. Hence there is greater heat and more florid colour of the ſkin in the former, with petechiæ, or purple ſpots, and aphthæ, or ſloughs in the throat, and generally with previous contagion.

When animal matter dies, as a ſlough in the throat, or the mortified part of a carbuncle, if it be kept moiſt and warm, as during its adheſion to a living body, it will ſoon putrefy. This and the origin of contagion from putrid animal ſubſtances, ſeem to have given riſe to the ſeptic and antiſeptic theory of theſe fevers.

The matter in puſtules and ulcers is thus liable to become putrid, and to produce microſcopic animalcula; the urine, if too long retained, may alſo gain a putreſcent ſmell, as well as the alvine feces; but ſome writers have gone ſo far as to believe, that the blood itſelf in theſe fevers has ſmelt putrid, when drawn from the arm of the patient; but this ſeems not well founded; ſince a ſingle particle of putrid matter taken into the blood can produce fever, how can we conceive that the whole maſs could continue a minute in a putrid ſtate without deſtroying life? Add to this, that putrid animal ſubſtances give up air, as in gangrenes; and that hence if the blood was putrid, air ſhould be given out, which in the blood-veſſels is known to occaſion immediate death.

In theſe ſenſitive fevers with ſtrong pulſe (or inflammations) there are two ſenſorial faculties concerned in producing the diſeaſe, viz. irritation and ſenſation; and hence, as their combined action is more violent, the general quantity of ſenſorial power becomes further exhauſted during the exacerbation, and the ſyſtem more rapidly weakened than in irritative fever with ſtrong pulſe; where the ſpirit of animation is weakened by but one mode of its exertion: ſo that this febris ſenſitiva pulſu forti (or inflammatory fever) may be conſidered as the febris irritativa pulſu forti, with the addition of inflammation; and the febris ſenſitiva pulſu debili (or malignant fever) may be conſidered as the febris irritativa pulſu debili (or nervous fever), with the addition of inflammation.

4. In theſe putrid or malignant fevers a deficiency of irritability accompanies the increaſe of ſenſibility; and by this waſte of ſenſorial power by the exceſs of ſenſation, which was already too ſmall, ariſes the delirium and ſtupor which ſo perpetually attend theſe inflammatory fevers with arterial debility. In theſe caſes the voluntary power firſt ceaſes to act from deficiency of ſenſorial ſpirit; and the ſtimuli from external bodies have no effect on the exhauſted ſenſorial power, and a delirium like a dream is the conſequence. At length the internal ſtimuli ceaſe to excite ſufficient irritation, and the ſecretions are either not produced at all, or too parſimonious in quantity. Amongſt theſe the ſecretion of the brain, or production of the ſenſorial power, becomes deficient, till at laſt all ſenſorial power ceaſes, except what

is juſt neceſſary to perform the vital motions, and a ſtupor ſucceeds; which is thus owing to the ſame cauſe as the preceding delirium exerted in a greater degree.

This kind of delirium is owing to a ſuſpenſion of volition, and to the diſobedience of the ſenſes to external ſtimuli, and is always occaſioned by great debility, or paucity of ſenſorial power; it is therefore a bad ſign at the end of inflammatory fevers, which had previous arterial ſtrength, as rheumatiſm, or pleuriſy, as it ſhews the preſence of great exhauſtion of ſenſorial power in a ſyſtem, which having lately been expoſed to great excitement, is not ſo liable to be ſtimulated into its healthy action, either by additional ſtimulus of food and medicines, or by the accumulation of ſenſorial power during its preſent torpor. In inflammatory fevers with debility, as thoſe termed putrid fevers, delirium is ſometimes, as well as ſtupor, rather a favourable ſign; as leſs ſenſorial power is waſted during its continuance (ſee Claſs II. 1. 6. 8.), and the conſtitution not having been previouſly expoſed to exceſs of ſtimulation, is more liable to be excited after previous quieſcence.

When the ſum of general pleaſurable ſenſation becomes too great, another kind of delirium ſupervenes, and the ideas thus excited are miſtaken for the irritations of external objects: ſuch a delirium is produced for a time by intoxicating drugs, as fermented liquors, or opium: a permanent delirium of this kind is ſometimes induced by the pleaſures of inordinate vanity, or by the enthuſiaſtic hopes of heaven. In theſe caſes the power of volition is incapable of exertion, and in a great degree the external ſenſes become incapable of perceiving their adapted ſtimuli, becauſe the whole ſenſorial power is employed or expended on the ideas excited by pleaſurable ſenſation.

This kind of delirium is diſtinguiſhed from that which attends the fevers above mentioned from its not being accompanied with general debility, but ſimply with exceſs of pleaſurable ſenſation; and is therefore in ſome meaſure allied to madneſs or to reverie; it differs from the delirium of dreams, as in this the power of volition is not totally ſuſpended, nor are the ſenſes precluded from external ſtimulation; there is therefore a degree of conſiſtency, in this kind of delirium, and a degree of attention to external objects, neither of which exiſts in the delirium of fevers or in dreams.

5. It would appear, that the vaſcular ſyſtems of other animals are leſs liable to be put into action by their general ſum of pleaſurable or painful ſenſation; and that the trains of their ideas, and the muſcular motions uſually aſſociated with them, are leſs powerfully connected than in the human ſyſtem. For other animals neither weep,

nor ſmile, nor laugh; and are hence ſeldom ſubject to delirium, as treated of in Sect. XVI. on Inſtinct. Now as our epidemic and contagious diſeaſes are probably produced by diſagreeable ſenſation, and not ſimply by irritation; there appears a reaſon, why brute animals are leſs liable to epidemic or contagious diſeaſes; and ſecondly, why none of our contagions, as the ſmall-pox or meaſles, can be communicated to them, though one of theirs, viz. the hydrophobia, as well as many of their poiſons, as thoſe of ſnakes and of inſects, communicate their deleterious or painful effects to mankind.

Where the quantity of general painful ſenſation is too great in the ſyſtem, inordinate voluntary exertions are produced either of our ideas, as in melancholy and madneſs, or of our muſcles, as in convulſion. From theſe maladies alſo brute animals are much more exempt than mankind, owing to their greater inaptitude to voluntary exertion, as mentioned in Sect. XVI. on Inſtinct.

II. 1. When any moving organ is excited into ſuch violent motions, that a quantity of pleaſurable or painful ſenſation is produced, it frequently happens (but not always) that new motions of the affected organ are generated in conſequence of the pain or pleaſure, which are termed inflammation.

Theſe new motions are of a peculiar kind, tending to diſtend the old, and to produce new fibres, and thence to elongate the ſtraight muſcles, which ſerve locomotion, and to form new veſſels at the extremities or ſides of the vaſcular muſcles.

2. Thus the pleaſurable ſenſations produce an enlargement of the nipples of nurſes, of the papillæ of the tongue, of the penis, and probably produce the growth of the body from its embryon ſtate to its maturity; whilſt the new motions in conſequence of painful ſenſation, with the growth of the fibres or veſſels, which they occaſion, are termed inflammation.

Hence when the ſtraight muſcles are inflamed, part of their tendons at each extremity gain new life and ſenſibility, and thus the muſcle is for a time elongated; and inflamed bones become ſoft, vaſcular, and ſenſible. Thus new veſſels ſhoot over the cornea of inflamed eyes, and into ſcirrhous tumours, when they become inflamed; and hence all inflamed parts grow together by intermixture, and inoſculation of the new and old veſſels.

The heat is occaſioned from the increaſed ſecretions either of mucus, or of the fibres, which produce or elongate the veſſels. The red colour is owing to the pellucidity of the newly formed veſſels, and as the arterial parts of them are probably formed before their correſpondent venous parts.

3. Theſe new motions are excited either from

the increaſed quantity of ſenſation in conſequence of greater fibrous contractions, or from increaſed ſenſibility, that is, from the increaſed quantity of ſenſorial power in the moving organ. Hence they are induced by great external ſtimuli, as by wounds, broken bones; and by acrid or infectious materials; or by common ſtimuli on thoſe organs, which have been ſome time quieſcent; as the uſual light of the day inflames the eyes of thoſe, who have been confined in dungeons; and the warmth of a common fire inflames thoſe, who have been previouſly expoſed to much cold.

But theſe new motions are never generated by that pain, which ariſes from defect of ſtimulus, as from hunger, thirſt, cold, or inanition, with all thoſe pains, which are termed nervous. Where theſe pains exiſt, the motions of the affected part are leſſened; and if inflammation ſucceeds, it is in ſome diſtant parts; as coughs are cauſed by coldneſs and moiſture being long applied to the feet; or it is in conſequence of the renewal of the ſtimulus, as of heat or food, which excites our organs into ſtronger action after their temporary quieſcence; as kibed heels after walking in ſnow.

4. But when theſe new motions of the vaſcular muſcles are exerted with greater violence, and theſe veſſels are either elongated too much or too haſtily, a new material is ſecreted from their extremities, which is of various kinds according to

the peculiar animal motions of this new kind of gland, which ſecretes it; ſuch is the pus laudabile or common matter, the variolous matter, venereal matter, catarrhous matter, and many others.

5. Theſe matters are the product of an animal proceſs; they are ſecreted or produced from the blood by certain diſeaſed motions of the extremities of the blood-veſſels, and are on that account all of them contagious; for if a portion of any of theſe is tranſmitted into the circulation, or perhaps only inſerted into the ſkin, or beneath the cuticle of a healthy perſon, its ſtimulus in a certain time produces the ſame kind of morbid motions, by which itſelf was produced; and hence a ſimilar kind is generated. See Sect. XXXIX. 6. 1.

6. It is remarkable, that many of theſe contagious matters are capable of producing a ſimilar diſeaſe but once; as the ſmall-pox and meaſles; and I ſuppoſe this is true of all thoſe contagious diſeaſes, which are ſpontaneouſly cured by nature in a certain time; for if the body was capable of receiving the diſeaſe a ſecond time, the patient muſt perpetually infect himſelf by the very matter, which he has himſelf produced, and is lodged about him; and hence he could never become free from the diſeaſe. Something ſimilar to this is ſeen in the ſecondary fever of the confluent ſmall-pox; there is a great abſorption of variolous matter, a very minute part of which would

give the genuine ſmall-pox to another perſon; but here it only ſtimulates the ſyſtem into common fever; like that which common pus, or any other acrid material might occaſion.

7. In the pulmonary conſumption, where common matter is daily abſorbed, an irritative fever only, without new inflammation, is generally produced; which is terminated like other irritative fevers by ſweats or looſe ſtools. Hence it does not appear, that this abſorbed matter always acts as a contagious material producing freſh inflammation or new abſceſſes. Though there is reaſon to believe, that the firſt time any common matter is abſorbed, it has this effect, but not the ſecond time, like the variolous matter above mentioned.

This accounts for the opinion, that the pulmonary conſumption is ſometimes infectious, which opinion was held by the ancients, and continues in Italy at preſent; and I have myſelf ſeen three or four inſtances, where a huſband and wife, who have ſlept together, and have thus much received each other's breath, who have infected each other, and both died in conſequence of the original taint of only one of them. This alſo accounts for the abſceſſes in various parts of the body, that are ſometimes produced after the inoculated ſmall-pox is terminated; for this ſecond abſorption of variolous matter acts like common matter, and produces only irritative fever in thoſe children, whoſe conſtitutions have already experienced the abſorption of common matter; and inflammation with a tendency to produce new abſceſſes in thoſe, whoſe conſtitutions have not experienced the abſorptions of common matter.

It is probable, that more certain proofs might have been found to ſhew, that common matter is infectious the firſt time it is abſorbed, tending to produce ſimilar abſceſſes, but not the ſecond time of its abſorption, if this ſubject had been attended to.

8. Theſe contagious diſeaſes are very numerous, as the plague, ſmall-pox, chicken pox, meaſles, ſcarlet-fever, pemphigus, catarrh, chincough, venereal diſeaſe, itch, trichoma, tinea. The infectious material does not ſeem to be diſſolved by the air, but only mixed with it perhaps in fine powder, which ſoon ſubſides; ſince many of theſe contagions can only be received by actual contact; and others of them only at ſmall diſtances from the infected perſon; as is evident from many perſons having been near patients of the ſmall-pox without acquiring the diſeaſe.

The reaſon, why many of theſe diſeaſes are received but once, and others repeatedly, is not well underſtood; it appears to me, that the conſtitution becomes ſo accuſtomed to the ſtimuli of theſe infectious materials, by having once experienced them, that though irritative motions, as hectic fevers, may again be produced by them, yet no ſenſation, and in conſequence no general inflammation ſucceeds; as diſagreeable ſmells or taſtes by habit ceaſe to be perceived; they continue indeed to excite irritative ideas on the organs of ſenſe, but theſe are not ſucceeded by ſenſation.

There are many irritative motions, which were at firſt ſucceeded by ſenſation, but which by frequent repetition ceaſe to excite ſenſation, as explained in Sect. XX. on Vertigo. And, that this circumſtance exiſts in reſpect to infectious matter appears from a known fact; that nurſes, who have had the ſmall-pox, are liable to experience ſmall ulcers on their arms by the contact of variolous matter in lifting their patients; and that when patients, who have formerly had the ſmall-pox have been inoculated in the arm, a phlegmon, or inflamed ſore, has ſucceeded, but no ſubſequent fever. Which ſhews, that the contagious matter of the ſmall-pox has not loſt its power of ſtimulating the part it is applied to, but that the general ſyſtem is not affected in conſequence. See Section XII. 7. 6. XIX. 10.

9. From the accounts of the plague, virulent catarrh, and putrid dyſentery, it ſeems uncertain, whether theſe diſeaſes are experienced more than once; but the venereal diſeaſe and itch are doubtleſs repeatedly infectious; and as theſe diſeaſes are never cured ſpontaneouſly, but require medicines, which act without apparent operation,

ſome have ſuſpected, that the contagious material produces ſimilar matter rather by a chemical change of the fluids, than by an animal proceſs; and that the ſpecific medicines deſtroy their virus by chemically combining with it. This opinion is ſucceſsfully combated by Mr. Hunter, in his Treatiſe on Venereal Diſeaſe, Part I. c. i.

But this opinion wants the ſupport of analogy, as there is no known proceſs in animal bodies, which is purely chemical, not even digeſtion; nor can any of theſe matters be produced by chemical proceſſes. Add to this, that it is probable, that the inſects, obſerved in the puſtules of the itch, and in the ſtools of dyſenteric patients, are the conſequences, and not the cauſes of theſe diſeaſes. And that the ſpecific medicines, which cure the itch, and lues venerea, as brimſtone and mercury, act only by increaſing the abſorption of the matter in the ulcuſcles of thoſe diſeaſes, and thence diſpoſing them to heal; which would otherwiſe continue to ſpread.

Why the venereal diſeaſe, and itch, and tinea, or ſcald head, are repeatedly contagious, while thoſe contagions attended with fever can be received but once, ſeems to depend on their being rather local diſeaſes than univerſal ones, and are hence not attended with fever, except the purulent fever in their laſt ſtages, when the patient is deſtroyed by them. On this account the whole of the ſyſtem does not become habituated to theſe morbid actions, ſo as to ceaſe to be affected with ſenſation by a repetition of the contagion. Thus the contagious matter of the venereal diſeaſe, and of the tinea, affects the lymphatic glands, as the inguinal glands, and thoſe about the roots of the hair and neck, where it is arreſted, but does not ſeem to affect the blood-veſſels, ſince no fever enſues.

Hence it would appear, that theſe kinds of contagion are propagated not by means of the circulation, but by ſympathy of diſtant parts with each other; ſince if a diſtant part, as the palate, ſhould be excited by ſenſitive aſſociation into the ſame kind of motions, as the parts originally affected by the contact of infectious matter; that diſtant part will produce the ſame kind of infectious matter; for every ſecretion from the blood is formed from it by the peculiar motions of the fine extremities of the gland, which ſecretes it; the various ſecreted fluids, as the bile, ſaliva, gaſtric juice, not previouſly exiſting, as ſuch, in the blood-veſſels.

And this peculiar ſympathy between the genitals and the throat, owing to ſenſitive aſſociation, appears not only in the production of venereal ulcers in the throat, but in a variety of other inſtances, as in the mumps, in the hydrophobia, ſome coughs, ſtrangulation, the production of the beard, change of voice at puberty. Which are further deſcribed in Claſs IV. 1. 2. 7.

To evince that the production of ſuch large quantities of contagious matter, as are ſeen in ſome variolous patients, ſo as to cover the whole ſkin almoſt with puſtules, does not ariſe from any chemical fermentation in the blood, but that it is owing to morbid motions of the fine extremities of the capillaries, or glands, whether theſe be ruptured or not, appears from the quantity of this matter always correſponding with the quantity of the fever; that is, with the violent exertions of thoſe glands and capillaries, which are the terminations of the arterial ſyſtem.

The truth of this theory is evinced further by a circumſtance obſerved by Mr. J. Hunter, in his Treatiſe on Venereal Diſeaſe; that in a patient, who was inoculated for the ſmall-pox, and who appeared afterwards to have been previouſly infected with the meaſles, the progreſs of the ſmall-pox was delayed till the meaſles had run their courſe, and that then the ſmall-pox went through its uſual periods.

Two ſimilar caſes fell under my care, which I ſhall here relate, as it confirms that of Mr. Hunter, and contributes to illuſtrate this part of the theory of contagious diſeaſes. I have tranſcribed the particulars from a letter of Mr. Lightwood, of Yoxal, the ſurgeon who daily attended them, and at my requeſt, after I had ſeen them, kept a kind of journal of their caſes.

Miſs H. and Miſs L. two ſiſters, the one about four and the other about three years old, were inoculated Feb. 7, 1791. On the 10th there was a redneſs on both arms diſcernible by a glaſs. On the 11th their arms were ſo much inflamed, as to leave no doubt of the infection having taken place. On the 12th leſs appearance of inflammation on their arms. In the evening Miſs L. had an eruption, which reſembled the meaſles. On the 13th the eruption on Miſs L. was very full on the face and breaſt, like the meaſles, with conſiderable fever. It was now known, that the meaſles were in a farm houſe in the neighbourhood. Miſs H.'s arm leſs inflamed than yeſterday. On the 14th Miſs L.'s fever great, and the eruption univerſal. The arm appears to be healed. Miſs H.'s arm ſomewhat redder. They were now put into ſeparate rooms. On the 15th Miſs L.'s arms as yeſterday. Eruption continues. Miſs H.'s arms have varied but little. 16th, the eruptions on Miſs L. are dying away, her fever gone. Begins to have a little redneſs in one arm at the place of inoculation. Miſs H.'s arms get redder, but ſhe has no appearance of complaint. 20th, Miſs L.'s arms have advanced ſlowly till this day, and now a few puſtules appear. Miſs H.'s arm has made little progreſs from the 16th to this day, and now ſhe has ſome fever. 21ſt, Miſs L. as yeſterday. Miſs H. has much inflammation, and an increaſe of the red circle on one arm to the ſize of half-a-crown, and had much fever at night, with fetid breath. 22d, Miſs L.'s puſtules continue advancing. Miſs H.'s inflammation of her arm and red circle increaſes. A few red ſpots appear in different parts with ſome degree of fever this morning. 23d, Miſs L. has a larger crop of puſtules. Miſs H. has ſmall puſtules and great inflammation of her arms, with but one puſtule likely to ſuppurate. After this day they gradually got well, and the puſtules diſappeared.

In one of theſe caſes the meaſles went through their common courſe with milder ſymptoms than uſual, and in the other the meaſly contagion ſeemed juſt ſufficient to ſtop the progreſs of variolous contagion, but without itſelf throwing the conſtitution into any diſorder. At the ſame time both the meaſles and ſmall-pox ſeem to have been rendered milder. Does not this give an idea, that if they were both inoculated at the ſame time, that neither of them might affect the patient?

From theſe caſes I contend, that the contagious matter of theſe diſeaſes does not affect the conſtitution by a fermentation, or chemical change of the blood, becauſe then they muſt have proceeded together, and have produced a third ſomething, not exactly ſimilar to either of them:

but that they produce new motions of the cutaneous terminations of the blood-veſſels, which for a time proceed daily with increaſing activity, like ſome paroxyſms of fever, till they at length ſecrete or form a ſimilar poiſon by theſe unnatural actions.

Now as in the meaſles one kind of unnatural motion takes place, and in the ſmall-pox another kind, it is eaſy to conceive, that theſe different kinds of morbid motions cannot exiſt together; and therefore, that that which has firſt begun will continue till the ſyſtem becomes habituated to the ſtimulus which occaſions it, and has ceaſed to be thrown into action by it; and then the other kind of ſtimulus will in its turn produce fever, and new kinds of motions peculiar to itſelf.

10. On further conſidering the action of contagious matter, ſince the former part of this work was ſent to the preſs; where I have aſſerted, in Sect. XXII. 4. 3. that it is probable, that the variolous matter is diffuſed through the blood; I prevailed on my friend Mr. Power, ſurgeon at Boſworth, in Leiceſterſhire, to try, whether the ſmall-pox could be inoculated by uſing the blood of a variolous patient inſtead of the matter from the puſtules; as I thought ſuch an experiment might throw ſome light at leaſt on this intereſting ſubject. The following is an extract from his letter:—

"March 11, 1793. I inoculated two children, who had not had the ſmall-pox, with blood; which was taken from a patient on the ſecond day after the eruption commenced, and before it was completed. And at the ſame time I inoculated myſelf with blood from the ſame perſon, in order to compare the appearances, which might ariſe in a perſon liable to receive the infection, and in one not liable to receive it. On the ſame day I inoculated four other children liable to receive the infection with blood taken from another perſon on the fourth day after the commencement of the eruption. The patients from whom the blood was taken had the diſeaſe mildly, but had the moſt puſtules of any I could ſelect from twenty inoculated patients; and as much of the blood was inſinuated under the cuticle as I could introduce by elevating the ſkin without drawing blood; and three or four ſuch punctures were made in each of their arms, and the blood was uſed in its fluid ſtate.

"As the appearances in all theſe patients, as well as in myſelf, were ſimilar, I ſhall only mention them in general terms. March 13. A ſlight ſubcuticular diſcoloration, with rather a livid appearance, without ſoreneſs or pain, was viſible in them all, as well as in my own hand. 15. The diſcoloration ſomewhat leſs, without pain or ſoreneſs. Some patients inoculated on the ſame day with variolous matter have conſiderable inflammation. 17. The diſcoloration is quite gone in them all, and from my own hand, a dry mark only remaining. And they were all inoculated on the 18th, with variolous matter, which produced the diſeaſe in them all."

Mr. Power afterwards obſerves, that, as the patients from whom the blood was taken had the diſeaſe mildly, it may be ſuppoſed, that though the contagious matter might be mixed with the blood, it might ſtill be in too dilute a ſtate to convey the infection; but adds at the ſame time, that he has diluted recent matter with at leaſt five times its quantity of water, and which has ſtill given the infection; though he has ſometimes diluted it ſo far as to fail.

The following experiments were inſtituted at my requeſt by my friend Mr. Hadley, ſurgeon in Derby, to aſcertain whether the blood of a perſon in the ſmall-pox be capable of communicating the diſeaſe. "Experiment 1ſt. October 18th, 1793. I took ſome blood from a vein in the arm of a perſon who had the ſmall-pox, on the ſecond day of the eruption, and introduced a ſmall quantity of it immediately with the point of a lancet between the ſcarf and true ſkin of the right arm of a boy nine years old in two or three different places; the other arm was inoculated with variolous matter at the ſame time.

"19th. The punctured parts of the right arm were ſurrounded with ſome degree of ſubcuticular inflammation. 20th. The inflammation more conſiderable, with a ſlight degree of itching, but no pain upon preſſure. 21ſt. Upon examining the arm this day with a lens, I found the inflammation leſs extenſive, and the redneſs changing to a deep yellow or orange-colour. 22d. Inflammation nearly gone. 23d. Nothing remained, except a ſlight diſcoloration and a little ſcurfy appearance on the punctures. At the ſame time the inflammation of the arm inoculated with variolous matter was increaſing faſt, and he had the diſeaſe mildly at the uſual time.

"Experiment 2d. I inoculated another child at the ſame time and in the ſame manner, with blood taken on the firſt day of the eruption; but as the appearance and effects were ſimilar to thoſe in the preceding experiment, I ſhall not relate them minutely.

"Experiment 3d. October 20th. Blood was taken from a perſon who had the ſmall-pox, on the third day of the eruption, and on the ſixth from the commencement of the eruptive fever. I introduced ſome of it in its fluid ſtate into both arms of a boy ſeven years old. 21. There appeared to be ſome inflammation under the cuticle, where the punctures were made. 22d. Inflammation more conſiderable. 23d. On this day the inflammation was ſomewhat greater, and the cuticle rather elevated.

"24th. Inflammation much leſs, and only a brown or orange-colour remained. 25th. Scarcely any diſcoloration left. On this day he was inoculated with variolous matter, the progreſs of the infection went on in the uſual way, and he had the ſmall-pox very favourably.

“At this time I was requeſted to inoculate a young perſon, who was thought to have had the ſmall-pox, but his parents were not quite certain; in one arm I introduced variolous matter, and in the other blood, taken as in experiment 3d. On the ſecond day after the operation, the punctured parts were inflamed, though I think the arm in which I had inſerted variolous matter was rather more ſo than the other. On the third the inflammation was increaſed, and looked much the ſame as in the preceding experiment. 4th. The inflammation was much diminiſhed, and on the 5th almoſt gone. He was expoſed at the ſame time to the natural infection, but has continued perfectly well.

“I have frequently obſerved (and believe moſt practitioners have done the ſame), that if variolous matter be inſerted in the arm of a perſon who has previouſly had the ſmall-pox, the inflammation on the ſecond or third day is much greater, than if they had not had the diſeaſe, but on the fourth or fifth it diſappears.

“On the 23d I introduced blood into the arms of three more children, taken on the third and fourth days of the eruption. The appearances were much the ſame as mentioned in experiments firſt and third. They were afterwards inoculated with variolous matter, and had the diſeaſe in the regular way.

"The above experiments were made with blood taken from a ſmall vein in the hand or foot of three or four different patients, whom I had at that time under inoculation. They were ſelected from 160, as having the greateſt number of puſtules. The part was waſhed with warm water before the blood was taken, to prevent the poſſibility of any matter being mixed with it from the ſurface."

Shall we conclude from hence, that the variolous matter never enters the blood-veſſels; but that the morbid motions of the veſſels of the ſkin around the inſertion of it continue to increaſe in a larger and larger circle for ſix or ſeven days; that then their quantity of morbid action becomes great enough to produce a fever-fit, and to affect the ſtomach by aſſociation of motions? and finally, that a ſecond aſſociation of motions is produced between the ſtomach and the other parts of the ſkin, inducing them into morbid actions ſimilar to thoſe of the circle round the inſertion of the variolous matter? Many more experiments and obſervations are required before this important queſtion can be ſatisfactorily anſwered.

It may be adduced, that as the matter inſerted into the ſkin of the arm frequently ſwells the lymphatic in the axilla, that in that circumſtance it ſeems to be there arreſted in its progreſs, and cannot be imagined to enter the blood by that lymphatic gland till the ſwelling of it ſubſides. Some other phænomena of the diſeaſe are more eaſily reconcileable to this theory of ſympathetic motions than to that of abſorption; as the time taken up between the inſertion of the matter, and the operation of it on the ſyſtem, as mentioned above. For the circle around the inſertion is ſeen to increaſe, and to inflame; and I believe, undergoes a kind of diurnal paroxyſm of torpor and paleneſs with a ſucceeding increaſe of action and colour, like a topical fever-fit. Whereas if the matter is conceived to circulate for ſix or ſeven days with the blood, without producing diſorder, it ought to be rendered milder, or the blood-veſſels more familiarized to its acrimony.

It is much eaſier to conceive from this doctrine of aſſociated or ſympathetic motions of diſtant parts of the ſyſtem, how it happens, that the variolous infection can be received but once, as before explained; than by ſuppoſing, that a change is effected in the maſs of blood by any kind of fermentative proceſs.

The curious circumſtance of the two contagions of ſmall-pox and meaſles not acting at the ſame time, but one of them reſting or ſuſpending its action till that of the other ceaſes, may be much eaſier explained from ſympathetic or aſſociated actions of the infected part with other parts of the ſyſtem, than it can from ſuppoſing the two contagions to enter the circulation.

The ſkin of the face is ſubject to more frequent viciſſitudes of heat and cold, from its expoſure to the open air, and is in conſequence more liable to ſenſitive aſſociation with the ſtomach than any other part of the ſurface of the body, becauſe their actions have been more frequently thus aſſociated. Thus in a ſurfeit from drinking cold water, when a perſon is very hot and fatigued, an eruption is liable to appear on the face in conſequence of this ſympathy. In the ſame manner the roſy eruption on the faces of drunkards more probably ariſes from the ſympathy of the face with the ſtomach, rather than between the face and the liver, as is generally ſuppoſed.

This ſympathy between the ſtomach and the ſkin of the face is apparent in the eruption of the ſmall-pox; ſince, where the diſeaſe is in conſiderable quantity, the eruption on the face firſt ſucceeds the ſickneſs of the ſtomach. In the natural diſeaſe the ſtomach ſeems to be frequently primarily affected, either alone or along with the tonſils, as the matter ſeems to be only diffuſed in the air, and by being mixed with the ſaliva, or mucus of the tonſils, to be ſwallowed into the ſtomach.

After ſome days the irritative circles of motions become diſordered by this new ſtimulus, which acts upon the mucous lining of the ſtomach; and ſickneſs, vertigo, and diurnal fever ſucceed. Theſe diſordered irritative motions become daily increaſed for two or three days, and then by their increaſed action certain ſenſitive motions, or inflammation, is produced, and at the next cold fit of fever, when the ſtomach recovers from its torpor, an inflammation of the external ſkin is formed in points (which afterwards ſuppurate), by ſenſitive aſſociation, in the ſame manner as a cough is produced in conſequence of expoſing the feet to cold, as deſcribed in Sect. XXV. 1. 1. and Claſs IV. 2. 1. 7. If the inoculated ſkin of the arm, as far as it appears inflamed, was to be cut out, or deſtroyed by cauſtic, before the fever commenced, as ſuppoſe on the fourth day after inoculation, would this prevent the diſeaſe? as it is ſuppoſed to prevent the hydrophobia.

III. 1. Where the new veſſels, and enlarged old ones, which conſtitute inflammation, are not ſo haſtily diſtended as to burſt, and form a new kind of gland for the ſecretion of matter, as above mentioned; if ſuch circumſtances happen as diminiſh the painful ſenſation, the tendency to growth ceaſes, and by and by an abſorption commences, not only of the ſuperabundant quantity of fluids depoſited in the inflamed part, but of the ſolids likewiſe, and this even of the hardeſt kind.

Thus during the growth of the ſecond ſet of teeth in children, the roots of the firſt ſet are totally abſorbed, till at length nothing of them remains but the crown; though a few weeks before, if they are drawn immaturely, their roots are found complete. Similar to this Mr. Hunter has obſerved, that where a dead piece of bone is to exfoliate, or to ſeparate from a living one, the dead part does not putrefy, but remains perfectly ſound, while the ſurface of the living part of the bone, which is in contact with the dead part, becomes abſorbed, and thus effects its ſeparation. Med. Comment. Edinb. V. 1. 425. In the ſame manner the calcareous matter of gouty concretions, the coagulable lymph depoſited on inflamed membranes in rheumatiſm and extravaſated blood become abſorbed; which are all as ſolid and as indiſſoluble materials as the new veſſels produced in inflammation.

This abſorption of the new veſſels and depoſited fluids of inflamed parts is called reſolution: it is produced by firſt uſing ſuch internal means as decreaſe the pain of the part, and in conſequence its new motions, as repeated bleeding, cathartics, diluent potations, and warm bath.

After the veſſels are thus emptied, and the abſorption of the new veſſels and depoſited fluids is evidently begun, it is much promoted by ſtimulating the part externally by ſolutions of lead, or other metals, and internally by the bark, and ſmall doſes of opium. Hence when an ophthalmy begins to become paler, any acrid eye-water, as a ſolution of ſix grains of white vitriol in an ounce of water, haſtens the abſorption, and clears the eye in a very ſhort time. But the ſame application uſed a few days ſooner would have increaſed the inflammation. Hence after evacuation opium in ſmall doſes may contribute to promote the abſorption of fluids depoſited on the brain, as obſerved by Mr. Bromfield in his treatiſe of ſurgery.

2. Where an abſceſs is formed by the rupture of theſe new veſſels, the violence of inflammation ceaſes, and a new gland ſeparates a material called pus: at the ſame time a leſs degree of inflammation produces new veſſels called vulgarly proud fleſh; which, if no bandage confines its growth, nor any other circumſtance promotes abſorption in the wound, would riſe to a great height above the uſual ſize of the part.

Hence the art of healing ulcers conſiſts in producing a tendency to abſorption in the wound greater than the depoſition. Thus when an ill-conditioned ulcer ſeparates a copious and thin diſcharge, by the uſe of any ſtimulus, as of ſalts of lead, or mercury, or copper externally applied, the diſcharge becomes diminiſhed in quantity, and becomes thicker, as the thinner parts are firſt abſorbed.

To which in ulcerations of the lungs, and in ſome catarrhs, a pertinacious abſtinence from fluids has been recommended, as well as in dropſies, and diabetes, which in the former as well as in the latter, may have a tendency to increaſe abſorption from the affected parts, and may thus be moderately employed with advantage; but may have a dangerous tendency if uſed to an extreme, by inducing too great thirſt, and conſequent fever or inflammation. Lower de Catarrhis. Davidſon on Pulmonary Syſtem. Rollo on Diabetes.

But nothing ſo much contributes to increaſe the abſorption in a wound as covering the whole limb above the ſore with a bandage, which ſhould be ſpread with ſome plaſter, as with emplaſtrum de minio, to prevent it from ſlipping. By this artificial tightneſs of the ſkin, the arterial pulſations act with double their uſual power in promoting the aſcending current of the fluid in the valvular lymphatics.

Internally the abſorption from ulcers ſhould be promoted firſt by evacuation, then by opium, bark, mercury, ſteel.

3. Where the inflammation proceeds with greater violence or rapidity, that is, when by the

painful ſenſation a more inordinate activity of the organ is produced, and by this great activity an additional quantity of painful ſenſation follows in an increaſing ratio, till the whole of the ſenſorial power, or ſpirit of animation, in the part becomes exhauſted, a mortification enſues, as in a carbuncle, in inflammations of the bowels, in the extremities of old people, or in the limbs of thoſe who are brought near a fire after having been much benumbed with cold. And from hence it appears, why weak people are more ſubject to mortification than ſtrong ones, and why in weak perſons leſs pain will produce mortification, namely, becauſe the ſenſorial power is ſooner exhauſted by any exceſs of activity. I remember ſeeing a gentleman who had the preceding day travelled two ſtages in a chaiſe with what he termed a bearable pain in his bowels; which when I ſaw him had ceaſed rather ſuddenly, and without a paſſage through him; his pulſe was then weak, though not very quick; but as nothing which he ſwallowed would continue in his ſtomach many minutes, I concluded that the bowel was mortified; he died on the next day. It is uſual for patients ſinking under the ſmall-pox with mortified puſtules, and with purple ſpots intermixed, to complain of no pain, but to ſay they are pretty well to the laſt moment.

Recapitulation.

IV. When the motions of any part of the ſyſtem, in conſequence of previous torpor, are performed with more energy than in the irritative fevers, a diſagreeable ſenſation is produced, and new actions of ſome part of the ſyſtem commence in conſequence of this ſenſation conjointly with the irritation: which motions conſtitute inflammation. If the fever be attended with a ſtrong pulſe, as in pleuriſy, or rheumatiſm, it is termed ſynocha ſenſitiva, or ſenſitive fever with ſtrong pulſe; which is uſually termed inflammatory fever. If it be attended with weak pulſe, it is termed typhus ſenſitivus, or ſenſitive fever with weak pulſe, or typhus gravior, or putrid malignant fever.

The ſynocha ſenſitiva, or ſenſitive fever with ſtrong pulſe, is generally attended with ſome topical inflammation, as in peripneumony, hepatitis, and is accompanied with much coagulable lymph, or ſize; which riſes to the ſurface of the blood, when taken into a baſon, as it cools; and which is believed to be the increaſed mucous ſecretion from the coats of the arteries, inſpiſſated by a greater abſorption of its aqueous and ſaline part, and perhaps changed by its delay in the circulation.

The typhus ſenſitivus, or ſenſitive fever with weak pulſe, is frequently attended with delirium, which is cauſed by the deficiency of the quantity of ſenſorial power, and with variety of cutaneous eruptions.

Inflammation is cauſed by the pains occaſioned by exceſs of action, and not by thoſe pains which are occaſioned by defect of action. Theſe morbid actions, which are thus produced by two ſenſorial powers, viz. by irritation and ſenſation, ſecrete new living fibres, which elongate the old veſſels, or form new ones, and at the ſame time much heat is evolved from theſe combinations. By the rupture of theſe veſſels, or by a new conſtruction of their apertures, purulent matters are ſecreted of various kinds; which are infectious the firſt time they are applied to the ſkin beneath the cuticle, or ſwallowed with the ſaliva into the ſtomach. This contagion acts not by its being abſorbed into the circulation, but by the ſympathies, or aſſociated actions, between the part firſt ſtimulated by the contagious matter and the other parts of the ſyſtem. Thus in the natural ſmall-pox the contagion is ſwallowed with the ſaliva, and by its ſtimulus inflames the ſtomach; this variolous inflammation of the ſtomach increaſes every day, like the circle round the puncture of an inoculated arm, till it becomes great enough to diſorder the circles of irritative and ſenſitive motions, and thus produces fever-fits, with ſickneſs and vomiting. Laſtly, after the cold paroxyſm,

yſm, or fit of torpor, of the ſtomach has increaſed for two or three ſucceſſive days, an inflammation of the ſkin commences in points; which generally firſt appear upon the face, as the aſſociated actions between the ſkin of the face and that of the ſtomach have been more frequently exerted together than thoſe of any other parts of the external ſurface.

Contagious matters, as thoſe of the meaſles and ſmall-pox, do not act upon the ſyſtem at the ſame time; but the progreſs of that which was laſt received is delayed, till the action of the former infection ceaſes. All kinds of matter, even that from common ulcers, are probably contagious the firſt time they are inſerted beneath the cuticle or ſwallowed into the ſtomach; that is, as they were formed by certain morbid actions of the extremities of the veſſels, they have the power to excite ſimilar morbid actions in the extremities of other veſſels, to which they are applied; and theſe by ſympathy, or aſſociations of motion, excite ſimilar morbid actions in diſtant parts of the ſyſtem, without entering the circulation; and hence the blood of a patient in the ſmall-pox will not give that diſeaſe by inoculation to others.

When the new fibres or veſſels become again abſorbed into the circulation, the inflammation ceaſes; which is promoted, after ſufficient evacuations, by external ſtimulants and bandages: but where the action of the veſſels is very great, a mortification of the part is liable to enſue, owing to the exhauſtion of ſenſorial power; which however occurs in weak people without much pain, and without very violent previous inflammation; and, like partial paralyſis, may be eſteemed one mode of natural death of old people, a part dying before the whole.

SECT. XXXIV.

DISEASES OF VOLITION.

I. 1. *Volition defined. Motions termed involuntary are cauſed by volition. Deſires oppoſed to each other. Deliberation. Aſs between two hay-cocks. Saliva ſwallowed againſt one's deſire. Voluntary motions diſtinguiſhed from thoſe aſſociated with ſenſitive motions.* 2. *Pains from exceſs, and from defect of motion. No pain is felt during vehement voluntary exertion; as in cold fits of ague, labour-pains, ſtrangury, teneſmus, vomiting, reſtleſſneſs in fevers, convulſion of a wounded muſcle.* 3. *Of holding the breath and ſcreaming in pain; why ſwine and dogs cry out in pain, and not ſheep and horſes. Of grinning and biting in pain; why mad animals bite others.* 4. *Epileptic convulſions explained, why the fits begin with quivering of the under jaw, biting the tongue, and ſetting the teeth; why the convulſive motions are alternately relaxed. The phænomenon of laughter explained. Why children cannot tickle themſelves. How ſome have died from immoderate laughter.* 5. *Of cataleptic ſpaſms, of the locked jaw, of painful cramps.* 6. *Syncope explained. Why no external objects are perceived in ſyncope.* 7. *Of palſy and apoplexy from violent exertions. Caſe of Mrs. Scot. From dancing, ſcating, ſwimming. Caſe of Mr. Nairn. Why palſies are not always immediately preceded by violent exertions. Palſy and epilepſy from diſeaſed livers. Why the right arm more frequently paralytic than the left. How paralytic limbs regain their motions.*

II. *Diſeaſes of the ſenſual motions from exceſs or defect of voluntary exertion.* 1. *Madneſs.* 2. *Diſtinguiſhed from delirium.* 3. *Why mankind more liable to inſanity than brutes. Suſpicion. Want of ſhame, and of cleanlineſs.* 5. *They bear cold, hunger, and fatigue. Charles* XII. *of Sweden.* 6. *Pleaſurable delirium, and inſanity. Child riding on a ſtick. Pains of martyrdom not felt.* 7. *Dropſy.* 8. *Inflammation cured by inſanity.* III. 1. *Pain relieved by reverie. Reverie is an exertion of voluntary and ſenſitive motions.* 2. *Caſe of reverie.* 3. *Lady ſuppoſed to have two ſouls.* 4. *Methods of relieving pain.*

I. 1. Before we commence this Section on Diſeaſed Voluntary Motions, it may be neceſſary to premiſe, that the word volition is not uſed in this work exactly in its common acceptation. Volition is ſaid in Section V. to bear the ſame analogy to deſire and averſion, which ſenſation does to pleaſure and pain. And hence that, when deſire or averſion produces any action of the muſcular fibres, or of the organs of ſenſe, it is termed volition; and the actions produced in conſequence are termed voluntary actions. Whence it appears, that motions of our muſcles or ideas may be produced in conſequence of deſire or averſion without our having the power to prevent them, and yet theſe motions may be termed voluntary, according to our definition of the word; though in common language they would be called involuntary.

The objects of deſire and averſion are generally at a diſtance, whereas thoſe of pleaſure and pain are immediately acting upon our organs. Hence, before deſire or averſion is exerted, ſo as to cauſe any actions, there is generally time for deliberation; which conſiſts in diſcovering the means to obtain the object of deſire, or to avoid the object of averſion; or in examining the good or bad conſequences, which may reſult from them. In this caſe it is evident, that we have a power to delay the propoſed action, or to perform it; and this power of chooſing, whether we ſhall act or not, is in common language expreſſed by the word volition, or will. Whereas in this work the word volition means ſimply the active ſtate of the ſenſorial faculty in producing motion in conſequence of deſire or averſion: whether we have the power of reſtraining that action, or not; that is, whether we exert any actions in conſequence of oppoſite deſires or averſions or not.

For if the objects of deſire or averſion are preſent, there is no neceſſity to inveſtigate or compare the *means* of obtaining them, nor do we always deliberate about their conſequences; that is, no deliberation neceſſarily intervenes, and in conſequence the power of chooſing to act or not is not exerted. It is probable, that this two-fold uſe of the word volition in all languages has confounded the metaphyſicians, who have diſputed about free will and neceſſity. Whereas from the above analyſis it would appear, that during our ſleep, we uſe no voluntary exertions at all; and in our waking hours, that they are the conſequence of deſire or averſion.

To will is to act in conſequence of deſire; but to deſire means to deſire ſomething, even if that ſomething be only to become free from the pain, which cauſes the deſire; for to deſire nothing is not to deſire; the word deſire, therefore, includes both the action and the object or motive; for the object and motive of deſire are the ſame thing. Hence to deſire without an object, that is, without a motive, is a ſoleciſm in language. As if one ſhould aſk, if you could eat without food, or breathe without air.

From this account of volition it appears, that convulſions of the muſcles, as in epileptic fits, may in the common ſenſe of that word be termed involuntary; becauſe no deliberation is interpoſed between the deſire or averſion and the conſequent action; but in the ſenſe of the word, as above defined, they belong to the claſs of voluntary motions, as delivered in Vol. II. Claſs III. If this uſe of the word be diſcordant to the ear of the reader, the term morbid voluntary motions, or motions in conſequence of averſion, may be ſubſtituted in its ſtead.

If a perſon has a deſire to be cured of the ague, and has at the ſame time an averſion (or contrary deſire(to ſwallowing an ounce of Peruvian bark;

he balances deſire againſt deſire, or averſion againſt averſion; and thus he acquires the power of chooſing, which is the common acceptation of the word *willing*. But in the cold fit of ague, after having diſcovered that the act of ſhuddering, or exerting the ſubcutaneous muſcles, relieves the pain of cold; he immediately exerts this act of volition, and ſhudders, as ſoon as the pain and conſequent averſion return, without any deliberation intervening; yet is this act, as well as that of ſwallowing an ounce of the bark, cauſed by volition; and that even though he endeavours in vain to prevent it by a weaker contrary volition. This recalls to our minds the ſtory of the hungry aſs between two hay-ſtacks, where the two deſires are ſuppoſed ſo exactly to counteract each other, that he goes to neither of the ſtacks, but periſhes by want. Now as two equal and oppoſite deſires are thus ſuppoſed to balance each other, and prevent all action, it follows, that if one of theſe hay-ſtacks was ſuddenly removed, the aſs would irreſiſtibly be hurried to the other, which in the common uſe of the word might be called an involuntary act; but which, in our acceptation of it, would be claſſed amongſt voluntary actions, as above explained.

Hence to deliberate is to compare oppoſing deſires or averſions, and that which is the moſt intereſting at length prevails, and produces action. Similar to this, where two pains oppoſe each other, the ſtronger or more intereſting one produces action; as in pleuriſy the pain from ſuffocation would produce expanſion of the lungs, but the pain occaſioned by extending the inflamed membrane, which lines the cheſt, oppoſes this expanſion, and one or the other alternately prevails.

When any one moves his hand quickly near another perſon's eyes, the eye lids inſtantly cloſe; this act in common language is termed involuntary, as we have not time to deliberate or to exert any contrary deſire or averſion, but in this work it would be termed a voluntary act, becauſe it is cauſed by the faculty of volition, and after a few trials the nictitation can be prevented by a contrary or oppoſing volition.

The power of oppoſing volitions is beſt exemplified in the ſtory of Mutius Scævola, who is ſaid to have thruſt his hand into the fire before Porcenna, and to have ſuffered it to be conſumed for having failed him in his attempt on the life of that general. Here the averſion for the loſs of fame, or the unſatisfied deſire to ſerve his country, the too prevalent enthuſiaſms at that time, were more powerful than the deſire of withdrawing his hand, which muſt be occaſioned by the pain of combuſtion; of theſe oppoſing volitions

Vincit amor patriæ, laudumque immenſa cupido.

If any one is told not to ſwallow his ſaliva for a minute, he ſoon ſwallows it contrary to his will, in the common ſenſe of that word; but this alſo is a voluntary action, as it is performed by the faculty of volition, and is thus to be underſtood. When the power of volition is exerted on any of our ſenſes, they become more acute, as in our attempts to hear ſmall noiſes in the night. As explained in Section XIX. 6. Hence by our attention to the fauces from our deſire not to ſwallow our ſaliva; the fauces become more ſenſible; and the ſtimulus of the ſaliva is followed by greater ſenſation, and conſequent deſire of ſwallowing it. So that the deſire or volition in conſequence of the increaſed ſenſation of the ſaliva is more powerful, than the previous deſire not to ſwallow it. See Vol. II. Deglutitio invita. In the ſame manner if a modeſt man wiſhes not to want to make water, when he is confined with ladies in a coach or an aſſembly-room; that very act of volition induces the circumſtance, which he wiſhes to avoid, as above explained; inſomuch that I once ſaw a partial inſanity, which might be called a voluntary diabetes, which was occaſioned by the fear (and conſequent averſion) of not being able to make water at all.

It is further neceſſary to obſerve here, to prevent any confuſion of voluntary, with ſenſitive, or aſſociate motions, that in all the inſtances of violent efforts to relieve pain, thoſe efforts are at firſt voluntary exertions; but after they have been frequently repeated for the purpoſe of relieving certain pains, they become aſſociated with thoſe pains, and ceaſe at thoſe times to be ſubſervient to the will; as in coughing, ſneezing, and ſtrangury. Of theſe motions thoſe which contribute to remove or diſlodge the offending cauſe, as the actions of the abdominal muſcles in parturition or in vomiting, though they were originally excited by volition, are in this work termed ſenſitive motions; but thoſe actions of the muſcles or organs of ſenſe, which do not contribute to remove the offending cauſe, as in general convulſions or in madneſs, are in this work termed voluntary motions, or motions in conſequence of averſion, though in common language they are called involuntary ones. Thoſe ſenſitive unreſtrainable actions, which contribute to remove the cauſe of pain are uniformly and invariably exerted, as in coughing or ſneezing; but thoſe motions which are exerted in conſequence of averſion without contributing to remove the painful cauſe, but only to prevent the ſenſation of it, as in epileptic, or cataleptic fits, are not uniformly and invariably exerted, but change from one ſet of muſcles to another, as will be further explained; and may by this criterion alſo be diſtinguiſhed from the former.

At the ſame time thoſe motions, which are excited by perpetual ſtimulus, or by aſſociation with each other, or immediately by pleaſurable or painful ſenſation, may properly be termed involuntary motions, as thoſe of the heart and arteries; as the faculty of volition ſeldom affects thoſe, except when it exiſts in unnatural quantity, as in maniacal people.

2. It was obſerved in Section XIV. on the Production of Ideas, that thoſe parts of the ſyſtem, which are uſually termed the organs of ſenſe, are liable to be excited into pain by the exceſs of the ſtimulus of thoſe objects, which are by nature adapted to affect them; as of too great light, ſound, or preſſure. But that theſe organs receive no pain from the defect or abſence of theſe ſtimuli, as in darkneſs or ſilence. But that our other organs of perception, which have generally been called appetites, as of hunger, thirſt, want of heat, want of freſh air, are liable to be affected with pain by the defect, as well as by the exceſs of their appropriated ſtimuli.

This exceſs or defect of ſtimulus is however to be conſidered only as the remote cauſe of the pain, the immediate cauſe being the exceſs or defect of the natural action of the affected part, according to Sect. IV. 5. Hence all the pains of the body may be divided into thoſe from exceſs of motion, and thoſe from defect of motion which diſtinction is of great importance in the knowledge and the cure of many diſeaſes. For as the pains from exceſs of motion either gradually ſubſide, or are in general ſucceeded by inflammation; ſo thoſe from defect of motion either gradually ſubſide, or are in general ſucceeded by convulſion, or madneſs. Theſe pains are eaſily diſtinguiſhable from each other by this circumſtance, that the former are attended with heat of the pained part, or of the whole body; whereas the latter exiſt without increaſe of heat in the pained part, and are generally attended with coldneſs of the extremities of the body; which is the true criterion of what have been called nervous pains.

Thus when any acrid material, as ſnuff or lime, falls into the eye, pain and inflammation and heat are produced from the exceſs of ſtimulus; but violent hunger, hemicrania, or the clavus hyſtericus, are attended with coldneſs of the extremities, and defect of circulation. When we are expoſed to great cold, the pain we experience from the deficiency of heat is attended with a quieſcence of the motions of the vaſcular ſyſtem; ſo that no inflammation is produced, but a great deſire of heat, and a tremulous motion of the ſubcutaneous muſcles, which is properly a convulſion in conſequence of this pain from defect of the ſtimulus of heat.

It was before mentioned, that as ſenſation conſiſts in certain movements of the ſenſorium, beginning at ſome of the extremities of it, and propagated to the central parts of it; ſo volition conſiſts of certain other movements of the ſenſorium, commencing in the central parts of it, and propagated to ſome of its extremities. This idea of theſe two great powers of motion in the animal machine is confirmed from obſerving, that they never exiſt in a great degree or univerſally at the ſame time; for while we ſtrongly exert our voluntary motions, we ceaſe to feel the pains or uneaſineſſes, which occaſioned us to exert them.

Hence during the time of fighting with fiſts or ſwords no pain is felt by the combatants, till they ceaſe to exert themſelves. Thus in the beginning of ague-fits the painful ſenſation of cold is diminiſhed, while the patient exerts himſelf in the ſhivering and gnaſhing of his teeth. He then ceaſes to exert himſelf, and the pain of cold returns; and he is thus perpetually induced to reiterate theſe exertions, from which he experiences a temporary relief. The ſame occurs in labour-pains, the exertion of the parturient woman relieves the violence of the pains for a time, which recur again ſoon after ſhe has ceaſed to uſe thoſe exertions. The ſame is true in many other painful diſeaſes, as in the ſtrangury, teneſmus, and the efforts of vomiting; all theſe diſagreeable ſenſations are diminiſhed or removed for a time by the various exertions they occaſion, and recur alternately with thoſe exertions.

The reſtleſſneſs in ſome fevers is an almoſt perpetual exertion of this kind, excited to relieve ſome diſagreeable ſenſations; the reciprocal oppoſite exertions of a wounded worm, the alternate emproſthotonos and opiſthotonos of ſome ſpaſmodic diſeaſes, and the intervals of all convulſions, from whatever cauſe, ſeem to be owing to this circumſtance of the laws of animation; that great or univerſal exertion cannot exiſt at the ſame time with great or univerſal ſenſation, though they can exiſt reciprocally; which is probably reſolvable into the more general law, that the whole ſenſorial power being expended in one mode of exertion, there is none to ſpare for any other. Whence ſyncope, or temporary apoplexy, ſucceeds to epileptic convulſions.

3. Hence when any violent pain afflicts us, of which we can neither avoid nor remove the cauſe, we ſoon learn to endeavour to alleviate it, by exerting ſome violent voluntary effort, as mentioned above; and are naturally induced to uſe thoſe muſcles for this purpoſe, which have been in the early periods of our lives moſt frequently or moſt powerfully exerted.

Now the firſt muſcles, which infants uſe moſt frequently, are thoſe of reſpiration; and on this account we gain a habit of holding our breath, at the ſame time that we uſe great efforts to exclude it, for this purpoſe of alleviating unavoidable pain; or we preſs out our breath through a ſmall aperture of the larynx, and ſcream violently, when the pain is greater than is relievable by the former mode of exertion. Thus children ſcream to relieve any pain either of body or mind, as from anger, or fear of being beaten.

Hence it is curious to obſerve, that thoſe animals, who have more frequently exerted their muſcles of reſpiration violently, as in talking, barking, or grunting, as children, dogs, hogs, ſcream much more, when they are in pain, than thoſe other animals, who uſe little or no language in their common modes of life; as horſes, ſheep, and cows.

The next moſt frequent or moſt powerful efforts, which infants are firſt tempted to produce, are thoſe with the muſcles in biting hard ſubſtances; indeed the exertion of theſe muſcles is very powerful in common maſtication, as appears from the pain we receive, if a bit of bone is unexpectedly found amongſt our ſofter food; and further appears from their acting to ſo great mechanical diſadvantage, particularly when we bite with the inciſores, or canine teeth; which are firſt formed, and thence are firſt uſed to violent exertion.

Hence when a perſon is in great pain, the cauſe of which he cannot remove, he ſets his teeth firmly together, or bites ſome ſubſtance between them with great vehemence, as another mode of violent exertion to produce a temporary relief. Thus we have a proverb where no help can be had in pain, “ to grin and abide;” and the tortures of hell are ſaid to be attended with “ gnaſhing of teeth.”

Hence in violent ſpaſmodic pains I have ſeen people bite not only their tongues, but their arms or fingers, or thoſe of the attendants, or any object which was near them; and alſo ſtrike, pinch, or tear, others or themſelves, particularly the part of their own body, which is painful at the time. Soldiers, who die of painful wounds in battle, are ſaid in Homer to bite the ground. Thus alſo in the bellon, or colica ſaturnina, the patients are ſaid to bite their own fleſh, and dogs in this diſeaſe to bite up the ground they lie upon. It is probable that the great endeavours to bite in mad dogs, and the violence of other mad animals, are owing to the ſame cauſe.

4. If the efforts of our voluntary motions are exerted with ſtill greater energy for the relief of ſome diſagreeable ſenſation, convulſions are produced; as the various kinds of epilepſy, and in ſome hyſteric paroxyſms. In all theſe diſeaſes a pain or diſagreeable ſenſation is produced, frequently by worms, or acidity in the bowels, or by a diſeaſed nerve in the ſide, or head, or by the pain of a diſeaſed liver.

In ſome conſtitutions a more intolerable degree of pain is produced in ſome part at a diſtance from the cauſe by ſenſitive aſſociation, as before explained; theſe pains in ſuch conſtitutions ariſe to ſo great a degree, that I verily believe no artificial tortures could equal ſome, which I have witneſſed; and am confident life would not have long been preſerved, unleſs they had been ſoon diminiſhed or removed by the univerſal convulſion of the voluntary motions, or by temporary madneſs.

In ſome of the unfortunate patients I have obſerved, the pain has riſen to an inexpreſſible degree, as above deſcribed, before the convulſions have ſupervened; and which were preceded by ſcreaming, and grinning; in others, as in the common epilepſy, the convulſion has immediately ſucceeded the commencement of the diſagreeable ſenſations; and as a ſtupor frequently ſucceeds the convulſions, they only ſeemed to remember that a pain at the ſtomach preceded the fit, or ſome other uneaſy feel; or more frequently retained no memory at all of the immediate cauſe of the paroxyſm. But even in this kind of epilepſy, where the patient does not recollect any preceding pain, the paroxyſms generally are preceded by a quivering motion of the under jaw, with a biting of the tongue; the teeth afterwards become preſſed together with vehemence, and the eyes are then convulſed, before the commencement of the univerſal convulſion; which are all efforts to relieve pain.

The reaſon why theſe convulſive motions are alternately exerted and remitted was mentioned above, and in Sect. XII. 1. 3. when the exertions are ſuch as give a temporary relief to the pain, which excites them, they ceaſe for a time, till the pain is again perceived; and then new exertions are produced for its relief. We ſee daily examples of this in the loud reiterated laughter of ſome people; the pleaſurable ſenſation, which excites this laughter, ariſes for a time ſo high as to change its name and become painful: the convulſive motions of the reſpiratory muſcles relieve the pain for a time; we are, however, unwilling to loſe the pleaſure, and preſently put a ſtop to this exertion, and immediately the pleaſure recurs, and again as inſtantly riſes into pain. All of us have felt the pain of immoderate laughter; children have been tickled into convulſions of the whole body; and others have died in the act of laughing; probably from a paralyſis ſucceeding the long continued actions of the muſcles of reſpiration.

Hence we learn the reaſon, why children, who are ſo eaſily excited to laugh by the tickling of other people's fingers, cannot tickle themſelves into laughter. The exertion of their hands in the endeavour to tickle themſelves prevents the neceſſity of any exertion of the reſpiratory muſcles to relieve the exceſs of pleaſurable affection. See Sect. XVII. 3. 5.

Chryſippus is recorded to have died laughing, when an aſs was invited to ſup with him. The ſame is related of one of the popes, who, when he was ill, ſaw a tame monkey at his bedſide put on the holy tiara. Hall. Phyſ. T. III. p. 306.

There are inſtances of epilepſy being produced by laughing recorded by Van Swieten, T. III. 402 and 308. And it is well known, that many people have died inſtantaneouſly from the painful exceſs of joy, which probably might have been prevented by the exertions of laughter.

Every combination of ideas, which we attend to, occaſions pain or pleaſure; thoſe which occaſion pleaſure, furniſh either ſocial or ſelfiſh pleaſure, either malicious or friendly, or laſcivious, or ſublime pleaſure; that is, they give us pleaſure mixed with other emotions, or they give us unmixed pleaſure, without occaſioning any other emotions or exertions at the ſame time. This unmixed pleaſure, if it be great, becomes painful, like all other animal motions from ſtimuli of every kind; and if no other exertions are occaſioned at the ſame time, we uſe the exertion of laughter to relieve this pain. Hence laughter is occaſioned by ſuch wit as excites ſimply pleaſure without any other emotion, ſuch as pity, love, reverence. For ſublime ideas are mixed with admiration, beautiful ones with love, new ones with ſurpriſe; and theſe exertions of our ideas prevent the action of laughter from being neceſſary to relieve the painful pleaſure above deſcribed. Whence laughable wit conſiſts of frivolous ideas, without connexions of any conſequence, ſuch as puns on words, or on phraſes, incongruous junctions of ideas; on which account laughter is ſo frequent in children.

Unmixed pleaſure leſs than that, which cauſes laughter, cauſes ſleep, as in ſinging children to ſleep, or in ſlight intoxication from wine or food. See Sect. XVIII. 12.

5. If the pains, or diſagreeable ſenſations, above deſcribed do not obtain a temporary relief from theſe convulſive exertions of the muſcles, thoſe convulſive exertions continue without remiſſion, and one kind of catalepſy is produced. Thus when a nerve or tendon produces great pain by its being inflamed or wounded, the patient ſets his teeth firmly together, and grins violently, to diminiſh the pain; and if the pain is not relieved by this exertion, no relaxation of the maxillary muſcles takes place, as in the convulſions above deſcribed, but the jaws remain firmly fixed together. This locked jaw is the moſt frequent inſtance of cataleptic ſpaſm, becauſe we are more inclined to exert the muſcles ſubſervient to maſtication from their early obedience to violent efforts of volition.

But in the caſe related in Sect. XIX. on Reverie, the cataleptic lady had pain in her upper teeth; and preſſing one of her hands vehemently againſt her cheek-bone to diminiſh this pain, it remained in that attitude for about half an hour twice a day, till the painful paroxyſm was over.

I have this very day ſeen a young lady in this diſeaſe, (with which ſhe has frequently been afflicted;) ſhe began to-day with violent pain ſhooting from one ſide of the forehead to the occiput, and after various ſtruggles lay on the bed with her fingers and wriſts bent and ſtiff for about two hours; in other reſpects ſhe ſeemed in a ſyncope with a natural pulſe. She then had intervals of pain and of ſpaſm, and took three grains of opium every hour till ſhe had taken nine grains, before the pains and ſpaſm ceaſed.

There is, however, another ſpecies of fixed ſpaſm, which differs from the former, as the pain exiſts in the contracted muſcle, and would ſeem rather to be the conſequence than the cauſe of the contraction, as in the cramp in the calf of the leg, and in many other parts of the body.

In theſe ſpaſms it ſhould ſeem, that the muſcle itſelf is firſt thrown into contraction by ſome diſagreeable ſenſation, as of cold; and that then the violent pain is produced by the great contraction of the muſcular fibres extending its own tendons, which are ſaid to be ſenſible to extenſion only; and is further explained in Sect. XVIII. 15.

6. Many inſtances have been given in this work, where after violent motions excited by irritation, the organ has become quieſcent to leſs, and even to the great irritation, which induced it

into violent motion; as after looking long at the ſun or any bright colour, they ceaſe to be ſeen; and after removing from bright day-light into a gloomy room, the eye cannot at firſt perceive the objects, which ſtimulate it leſs. Similar to this is the ſyncope, which ſucceeds after the violent exertions of our voluntary motions, as after epileptic fits, for the power of volition acts in this caſe as the ſtimulus in the other. This ſyncope is a temporary palſy, or apoplexy, which ceaſes after a time, the muſcles recovering their power of being excited into action by the efforts of volition; as the eye in the circumſtance above mentioned recovers in a little time its power of ſeeing objects in a gloomy room; which were inviſible immediately after coming out of a ſtronger light. This is owing to an accumulation of ſenſorial power during the inaction of thoſe fibres, which were before accuſtomed to perpetual exertions, as explained in Sect. XII. 7. 1. A ſlighter degree of this diſeaſe is experienced by every one after great fatigue, when the muſcles gain ſuch inability to further action, that we are obliged to reſt them for a while, or to ſummon a greater power of volition to continue their motions.

In all the ſyncopes, which I have ſeen induced after convulſive fits, the pulſe has continued natural, though the organs of ſenſe, as well as the locomotive muſcles, have ceaſed to perform their functions; for it is neceſſary for the perception of objects, that the external organs of ſenſe ſhould be properly excited by the voluntary power, as the eye-lids muſt be open, and perhaps the muſcles of the eye put into action to diſtend, and thence give greater pellucidity to the cornea, which in ſyncope, as in death, appears flat and leſs tranſparent. The tympanum of the ear alſo ſeems to require a voluntary exertion of its muſcles, to gain its due tenſion, and it is probable the other external organs of ſenſe require a ſimilar voluntary exertion to adapt them to the diſtinct perception of objects. Hence in ſyncope as in ſleep, as the power of volition is ſuſpended, no external objects are perceived. See Sect. XVIII. 5. During the time which the patient lies in a fainting fit, the ſpirit of animation becomes accumulated; and hence the muſcles in a while become irritable by their uſual ſtimulation, and the fainting fit ceaſes. See Sect. XII. 7. 1.

7. If the exertion of the voluntary motions has been ſtill more energetic, the quieſcence, which ſucceeds, is ſo complete, that they cannot again be excited into action by the efforts of the will. In this manner the palſy, and apoplexy (which is an univerſal palſy) are frequently produced after convulſions, or other violent exertions; of this I ſhall add a few inſtances.

Platnerus mentions ſóme, who have died apoplectic from violent exertions in dancing; and

Dr. Mead, in his eſſay on Poiſons, records a patient in the hydrophobia, who at one effort broke the cords which bound him, and at the ſame inſtant expired. And it is probable, that thoſe, who have expired from immoderate laughter, have died from this paralyſis conſequent to violent exertion. Mrs. Scott of Stafford was walking in her garden in perfect health with her neighbour Mrs. —— ; the latter accidentally fell into a muddy rivulet, and tried in vain to diſengage herſelf by the aſſiſtance of Mrs. Scott's hand. Mrs. Scott exerted her utmoſt power for many minutes, firſt to aſſiſt her friend, and next to prevent herſelf from being pulled into the moraſs, as her diſtreſſed companion would not diſengage her hand. After other aſſiſtance was procured by their united ſcreams, Mrs. Scott walked to a chair about twenty yards from the brook, and was ſeized with an apoplectic ſtroke: which continued many days, and terminated in a total loſs of her right arm, and her ſpeech; neither of which ſhe ever after perfectly recovered.

It is ſaid, that many people in Holland have died after ſkating too long or too violently on their frozen canals; it is probable the death of theſe, and of others, who have died ſuddenly in ſwimming, has been owing to this great quieſcence or paralyſis; which has ſucceeded very violent exertions, added to the concomitant cold, which has had greater effect after the ſufferers had been heated and exhauſted by previous exerciſe.

I remember a young man of the name of Nairne at Cambridge, who walking on the edge of a barge fell into the river. His couſin and fellow-ſtudent of the ſame name, knowing the other could not ſwim, plunged into the water after him, caught him by his clothes, and approaching the bank by a vehement exertion propelled him ſafe to the land, but that inſtant, ſeized, as was ſuppoſed, by the cramp, or paralyſis, ſunk to riſe no more. The reaſon why the cramp of the muſcles, which compoſe the calf of the leg, is ſo liable to affect ſwimmers, is, becauſe theſe muſcles have very weak antagoniſts, and are in walking generally elongated again after their contraction by the weight of the body on the ball of the toe, which is very much greater than the reſiſtance of the water in ſwimming. See Section XVIII. 15.

It does not follow that every apoplectic or paralytic attack is immediately preceded by vehement exertion; the quieſcence, which ſucceeds exertion, and which is not ſo great as to be termed paralyſis, frequently recurs afterwards at certain periods; and by other cauſes of quieſcence, occurring with thoſe periods, as was explained in treating of the paroxyſms of intermitting fevers; the quieſcence at length becomes ſo great as to be incapable of again being removed by the efforts of volition, and complete paralyſis is formed. See Section XXXII. 3. 2.

Many of the paralytic patients, whom I have ſeen, have evidently had diſeaſed livers from the too frequent potation of ſpirituous liquors; ſome of them have had the gutta roſea on their faces and breaſts; which has in ſome degree receded either ſpontaneouſly, or by the uſe of external remedies, and the paralytic ſtroke has ſucceeded; and as in ſeveral perſons, who have drunk much vinous ſpirits, I have obſerved epileptic fits to commence at about forty or fifty years of age, without any hereditary taint, from the ſtimulus, as I believed, of a diſeaſed liver; I was induced to aſcribe many paralytic caſes to the ſame ſource; which were not evidently the effect of age, or of unacquired debility. And the account given before of dropſies, which very frequently are owing to a paralyſis of the abſorbent ſyſtem, and are generally attendant on free drinkers of ſpirituous liquors, confirmed me in this opinion.

The diſagreeable irritation of a diſeaſed liver produces exertions and conſequent quieſcence; theſe by the accidental concurrence of other cauſes of quieſcence, as cold, ſolar or lunar periods, inanition, the want of their uſual portion of ſpirit of wine, at length produces paralyſis.

This is further confirmed by obſerving, that the muſcles, we moſt frequently, or moſt powerfully exert, are moſt liable to palſy; as thoſe of the voice and of articulation, and of thoſe paralytics which I have ſeen, a much greater proportion have loſt the uſe of their right arm; which is ſo much more generally exerted than the left.

I cannot diſmiſs this ſubject without obſerving, that after a paralytic ſtroke, if the vital powers are not much injured, the patient has all the movements of the affected limb to learn over again, juſt as in early infancy; the limb is firſt moved by the irritation of its muſcles, as in ſtretching, (of which a caſe was related in Section VII. 1. 3.) or by the electric concuſſion; afterwards it becomes obedient to ſenſation, as in violent danger or fear; and laſtly, the muſcles become again aſſociated with volition, and gradually acquire their uſual habits of acting together.

Another phænomenon in palſies is, that when the limbs of one ſide are diſabled, thoſe of the other are in perpetual motion. This can only be explained from conceiving that the power of motion, whatever it is, or wherever it reſides, and which is capable of being exhauſted by fatigue, and accumulated in reſt, is now leſs expended, whilſt one half of the body is incapable of receiving its uſual proportion of it, and is hence derived with greater eaſe or in greater abundance into the limbs, which remain unaffected.

II. 1. The exceſs or defect of voluntary exertion produces ſimilar effects upon the ſenſual motions, or ideas of the mind, as thoſe already mentioned upon the muſcular fibres. Thus when any violent pain, ariſing from the defect of ſome peculiar ſtimulus, exiſts either in the muſcular or ſenſual ſyſtems of fibres, and which cannot be removed by acquiring the defective ſtimulus; as in ſome conſtitutions convulſions of the muſcles are produced to procure a temporary relief, ſo in other conſtitutions vehement voluntary exertions of the ideas of the mind are produced for the ſame purpoſe; for during this exertion, like that of the muſcles, the pain either vaniſhes or is diminiſhed: this violent exertion conſtitutes madneſs; and in many caſes I have ſeen the madneſs take place, and the convulſions ceaſe, and reciprocally the madneſs ceaſe, and the convulſions ſupervene. See Section III. 5. 8.

2. Madneſs is diſtinguiſhable from delirium, as in the latter the patient knows not the place where he reſides, nor the perſons of his friends or attendants, nor is conſcious of any external objects, except when ſpoken to with a louder voice, or ſtimulated with unuſual force, and even then he ſoon relapſes into a ſtate of inattention to every thing about him. Whilſt in the former he is perfectly ſenſible to every thing external, but has the voluntary powers of his mind intenſely exerted on ſome particular object of his deſire or averſion, he harbours in his thoughts a ſuſpicion of all mankind, leſt they ſhould coun-

teract his deſigns; and while he keeps his intentions, and the motives of his actions profoundly ſecret; he is perpetually ſtudying the means of acquiring the object of his wiſh, or of preventing or revenging the injuries he ſuſpects.

3. A late French philoſopher, Mr. Helvetius, has deduced almoſt all our actions from this principle of their relieving us from the ennui or tædium vitæ; and true it is, that our deſires or averſions are the motives of all our voluntary actions; and human nature ſeems to excel other animals in the more facile uſe of this voluntary power, and on that account is more liable to inſanity than other animals. But in mania this violent exertion of volition is expended on miſtaken objects, and would not be relieved, though we were to gain or eſcape the objects, that excite it. Thus I have ſeen two inſtances of madmen, who conceived that they had the itch, and ſeveral have believed they had the venereal infection, without in reality having a ſymptom of either of them. They have been perpetually thinking upon this ſubject, and ſome of them were in vain ſalivated with deſign of convincing them to the contrary.

4. In the minds of mad people thoſe volitions alone exiſt, which are unmixed with ſenſation; immoderate ſuſpicion is generally the firſt ſymptom, and want of ſhame, and want of delicacy

about cleanlineſs. Suſpicion is a voluntary exertion of the mind ariſing from the pain of fear, which it is exerted to relieve: ſhame is the name of a peculiar diſagreeable ſenſation, ſee Fable of the Bees, and delicacy about cleanlineſs ariſes from another diſagreeable ſenſation. And therefore are not found in the minds of maniacs, which are employed ſolely in voluntary exertions. Hence the moſt modeſt women in this diſeaſe walk naked amongſt men without any kind of concern, uſe obſcene diſcourſe, and have no delicacy about their natural evacuations.

5. Nor are maniacal people more attentive to their natural appetites, or to the irritations which ſurround them, except as far as may reſpect their ſuſpicions or deſigns; for the violent and perpetual exertions of their voluntary powers of mind prevent their perception of almoſt every other object, either of irritation or of ſenſation. Hence it is that they bear cold, hunger, and fatigue, with much greater pertinacity than in their ſober hours, and are leſs injured by them in reſpect to their general health. Thus it is aſſerted by hiſtorians, that Charles the Twelfth of Sweden ſlept on the ſnow, wrapped only in his cloak, at the ſiege of Frederickſtad, and bore extremes of cold and hunger, and fatigue, under which numbers of his ſoldiers periſhed; becauſe the king was inſane with ambition, but the ſoldier

had no ſuch powerful ſtimulus to preſerve his ſyſtem from debility and death.

6. Beſides the inſanities ariſing from exertions in conſequence of pain, there is alſo a pleaſurable inſanity, as well as a pleaſurable delirium; as the inſanity of perſonal vanity, and that of religious fanaticiſm. When agreeable ideas excite into motion the ſenſorial power of ſenſation, and this again cauſes other trains of agreeable ideas, a conſtant ſtream of pleaſurable ideas ſucceeds, and produces pleaſurable delirium. So when the ſenſorial power of volition excites agreeable ideas, and the pleaſure thus produced excites more volition in its turn, a conſtant flow of agreeable voluntary ideas ſucceeds; which when thus exerted in the extreme conſtitutes inſanity.

Thus when our muſcular actions are excited by our ſenſations of pleaſure, it is termed play; when they are excited by our volition, it is termed work; and the former of theſe is attended with leſs fatigue, becauſe the muſcular actions in play produce in their turn more pleaſurable ſenſation; which again has the property of producing more muſcular action. An agreeable inſtance of this I ſaw this morning. A little boy, who was tired with walking, begged of his papa to carry him. "Here," ſays the reverend doctor, "ride upon my gold-headed cane;" and the pleaſed child, putting it between his legs, gallopped away with delight, and complained no more of his fatigue. Here the aid of another ſenſorial power, that of pleaſurable ſenſation, ſuperadded vigour to the exertion of exhauſted volition. Which could otherwiſe only have been excited by additional pain, as by the laſh of ſlavery. On this account where the whole ſenſorial power has been exerted on the contemplation of the promiſed joys of heaven, the ſaints of all perſecuted religions have borne the tortures of martyrdom with otherwiſe unaccountable firmneſs.

7. There are ſome diſeaſes, which obtain at leaſt a temporary relief from the exertions of inſanity; many inſtances of dropſies being thus for a time cured are recorded. An elderly woman labouring with aſcites I twice ſaw relieved for ſome weeks by inſanity, the dropſy ceaſed for ſeveral weeks, and recurred again alternating with the inſanity. A man afflicted with difficult reſpiration on lying down, with very irregular pulſe, and œdematous legs, whom I ſaw this day, has for above a week been much relieved in reſpect to all thoſe ſymptoms by the acceſſion of inſanity, which is ſhewn by inordinate ſuſpicion, and great anger.

In caſes of common temporary anger the increaſed action of the arterial ſyſtem is ſeen by the red ſkin, and increaſed pulſe, with the immediate increaſe of muſcular activity. A friend of mine, when he was painfully fatigued by riding on horſeback, was accuſtomed to call up ideas into his mind, which uſed to excite his anger or indignation, and thus for a time at leaſt relieved the pain of fatigue. By this temporary inſanity, the effect of the voluntary power upon the whole of his ſyſtem was increaſed; as in the caſes of dropſy above mentioned, it would appear, that the increaſed action of the voluntary faculty of the ſenſorium affected the abſorbent ſyſtem, as well as the ſecerning one.

8. In reſpect to relieving inflammatory pains, and removing fever, I have ſeen many inſtances, as mentioned in Sect. XII. 2. 4. One lady, whom I attended, had twice at ſome years interval a locked jaw, which relieved a pain on her ſternum with peripneumony. Two other ladies I ſaw, who towards the end of violent peripneumony, in which they frequently loſt blood, were at length cured by inſanity ſupervening. In the former the increaſed voluntary exertion of the muſcles of the jaw, in the latter that of the organs of ſenſe, removed the diſeaſe; that is, the diſagreeable ſenſation, which had produced the inflammation, now excited the voluntary power, and theſe new voluntary exertions employed or expended the ſuperabundant ſenſorial power, which had previouſly been exerted on the arterial ſyſtem, and cauſed inflammation.

Another caſe which I think worth relating, was of a young man about twenty; he had laboured under an irritative fever with debility for three or four weeks, with very quick and very feeble pulſe, and other uſual ſymptoms of that ſpecies of typhus, but at this time complained much and frequently of pain of his legs and feet. When thoſe who attended him were nearly in deſpair of his recovery, I obſerved with pleaſure an inſanity of mind ſupervene: which was totally different from delirium, as he knew his friends, calling them by their names, and the room in which he lay, but became violently ſuſpicious of his attendants, and calumniated with vehement oaths his tender mother, who ſat weeping by his bed. On this his pulſe became ſlower and firmer, but the quickneſs did not for ſome time intirely ceaſe, and he gradually recovered. In this caſe the introduction of an increaſed quantity of the power of volition gave vigour to thoſe movements of the ſyſtem, which are generally only actuated by the power of irritation, and of aſſociation.

Another caſe I recollect of a young man, about twenty-five, who had the ſcarlet-fever, with very quick pulſe, and an univerſal eruption on his ſkin, and was not without reaſon eſteemed to be in great danger of his life. After a few days an inſanity ſupervened, which his friends miſtook for delirium, and he gradually recovered, and the cuticle peeled ed off. From theſe and a few other caſes I have always eſteemed inſanity to be a favourable ſign in fevers, and have cautiouſly diſtinguiſhed it from delirium.

III. Another mode of mental exertion to relieve pain, is by producing a train of ideas not only by the efforts of volition, as in inſanity; but by thoſe of ſenſation likewiſe, as in delirium and ſleep. This mental effort is termed reverie, or ſomnambulation, and is deſcribed more at large in Sect. XIX. on that ſubject. But I ſhall here relate another caſe of that wonderful diſeaſe, which fell yeſterday under my eye, and to which I have ſeen many analogous alienations of mind, though not exactly ſimilar in all circumſtances. But as all of them either began or terminated with pain or convulſion, there can be no doubt but that they are of epileptic origin, and conſtitute another mode of mental exertion to relieve ſome painful ſenſation.

1. Maſter A. about nine years old, had been ſeized at ſeven every morning for ten days with uncommon fits, and had had ſlight returns in the afternoon. They were ſuppoſed to originate from worms, and had been in vain attempted to be removed by vermifuge purges. As his fit was expected at ſeven yeſterday morning, I ſaw him before that hour; he was aſleep, ſeemed free from pain, and his pulſe natural. About ſeven he began to complain of pain about his navel, or more

to the left ſide, and in a few minutes had exertions of his arms and legs like ſwimming. He then for half an hour hunted a pack of hounds; as appeared by his hallooing, and calling the dogs by their names, and diſcourſing with the attendants of the chaſe, deſcribing exactly a day of hunting, which (I was informed) he had witneſſed a year before, going through all the moſt minute circumſtances of it; calling to people, who were then preſent, and lamenting the abſence of others, who were then alſo abſent. After this ſcene he imitated, as he lay in bed, ſome of the plays of boys, as ſwimming and jumping. He then ſung an Engliſh and then an Italian ſong; part of which with his eyes open, and part with them cloſed, but could not be awakened or excited by any violence, which it was proper to uſe.

After about an hour he came ſuddenly to himſelf with apparent ſurpriſe, and ſeemed quite ignorant of any part of what had paſſed, and after being apparently well for half an hour, he ſuddenly fell into a great ſtupor, with ſlower pulſe than natural, and a ſlow moaning reſpiration, in which he continued about another half hour, and then recovered.

The ſequel of this diſeaſe was favourable; he was directed one grain of opium at ſix every morning, and then to riſe out of bed; at half paſt ſix he was directed fifteen drops of laudanum in a glaſs of wine and water. The firſt day the paroxyſm became ſhorter, and leſs violent. The doſe of opium was increaſed to one-half more, and in three or four days the fits left him. The bark and filings of iron were alſo exhibited twice a day; and I believe the complaint returned no more.

2. In this paroxyſm it muſt be obſerved, that he began with pain, and ended with ſtupor, in both circumſtances reſembling a fit of epilepſy. And that therefore the exertions both of mind and body, both the voluntary ones, and thoſe immediately excited by pleaſurable ſenſation, were exertions to relieve pain.

The hunting ſcene appeared to be rather an act of memory than of imagination, and was therefore rather a voluntary exertion, though attended with the pleaſurable eagerneſs, which was the conſequence of thoſe ideas recalled by recollection, and not the cauſe of them.

Theſe ideas thus voluntarily recollected were ſucceeded by ſenſations of pleaſure, though his ſenſes were unaffected by the ſtimuli of viſible or audible objects; or ſo weakly excited by them as not to produce ſenſation or attention. And the pleaſure thus excited by volition produced other ideas and other motions in conſequence of the ſenſorial power of ſenſation. Whence the mixed catenations of voluntary and ſenſitive ideas and muſcular motions in reverie; which, like every other kind of vehement exertion, contribute to relieve pain, by expending a large quantity of ſenſorial power.

Thoſe fits generally commence during ſleep, from whence I ſuppoſe they have been thought to have ſome connexion with ſleep, and have thence been termed Somnambuliſm; but their commencement during ſleep is owing to our increaſed excitability by internal ſenſations at that time, as explained in Sect. XVIII. 14 and 15, and not to any ſimilitude between reverie and ſleep.

3. I was once concerned for a very elegant and ingenious young lady, who had a reverie on alternate days, which continued nearly the whole day; and as in her days of diſeaſe ſhe took up the ſame kind of ideas, which ſhe had converſed about on the alternate day before, and could recollect nothing of them on her well day; ſhe appeared to her friends to poſſeſs two minds. This caſe alſo was of the epileptic kind, and was cured, with ſome relapſes, by opium adminiſtered before the commencement of the paroxyſm.

4. Whence it appears, that the methods of relieving inflammatory pains, is by removing all ſtimulus, as by veneſection, cool air, mucilaginous diet, aqueous potation, ſilence, darkneſs.

The methods of relieving pains from defect of ſtimulus is by ſupplying the peculiar ſtimlus required, as of food, or warmth.

And the general method of relieving pain is by exciting into action ſome great part of the ſyſtem for the purpoſe of expending a part of the ſenſorial power. This is done either by exertion of the voluntary ideas and muſcles, as in inſanity and convulſion; or by exerting both voluntary and ſenſitive motions, as in reverie; or by exciting the irritative motions by wine or opium internally, and by the warm bath or bliſters externally; or laſtly, by exciting the ſenſitive ideas by good news, affecting ſtories, or agreeable paſſions.

SECT. XXXV.

DISEASES OF ASSOCIATION.

I. 1. *Sympathy or conſent of parts. Primary and ſecondary parts of an aſſociated train of motions reciprocally affect each other. Parts of irritative trains of motion affect each other in four ways. Sympathies of the ſkin and ſtomach. Fluſhing of the face after a meal. Eruption of the ſmall-pox on the face. Chilneſs after a meal.* 2. *Vertigo from intoxication.* 3. *Abſorption from the lungs and pericardium by emetics. In vomiting the actions of the ſtomach are decreaſed, not increaſed. Digeſtion ſtrengthened after an emetic. Vomiting from deficiency of ſenſorial power.* 4. *Dyſpnœa from cold bathing. Slow pulſe from digitalis. Death from gout in the ſtomach.* II. 1. *Primary and ſecondary parts of ſenſitive aſſociations affect each other. Pain from gall-ſtone, from urinary ſtone. Hemicrania. Painful epilepſy.* 2. *Gout and red face from inflamed liver. Shingles from inflamed kidney.* 3. *Coryza from cold applied to the feet. Pleuriſy. Hepatitis.* 4. *Pain of ſhoulders from inflamed liver.* III. *Diſeaſes from the aſſociations of ideas.*

I. 1. MANY ſynchronous and ſucceſſive motions of our muſcular fibres, and of our organs of ſenſe, or ideas, become aſſociated ſo as to form indiſſoluble tribes or trains of action, as ſhewn in Section X. on Aſſociate Motions. Some conſtitutions more eaſily eſtabliſh theſe aſſociations, whether by voluntary, ſenſitive, or irritative repetitions, and ſome more eaſily loſe them again, as ſhewn in Section XXXI. on Temperaments.

When the beginning of ſuch a train of actions becomes by any means diſordered, the ſucceeding part is liable to become diſturbed in conſequence, and this is commonly termed ſympathy or conſent of parts by the writers of medicine. For the more clear underſtanding of theſe ſympathies we muſt conſider a tribe or train of actions as divided into two parts, and call one of them the primary or original motions, and the other the ſecondary or ſympathetic ones.

The primary and ſecondary parts of a train of irritative actions may reciprocally affect each other in four different manners. 1. They may both be exerted with greater energy than natural. 2. The former may act with greater, and the latter with leſs energy. 3. The former may act with leſs, and the latter with greater energy. 4. They may both act with leſs energy than natural. I ſhall now give an example of each kind of theſe modes of action, and endeavour to ſhew, that though the primary and ſecondary parts of theſe trains or tribes of motion are connected by irritative aſſociation, or their previous habits of acting together, as deſcribed in Sect. XX. on Vertigo. Yet that their acting with ſimilar or diſſimilar degrees of energy, depends on the greater or leſs quantity of ſenſorial power, which the primary part of the train expends in its exertions.

The actions of the ſtomach conſtitute ſo important a part of the aſſociations of both irritative and ſenſitive motions, that it is ſaid to ſympathize with almoſt every part of the body; the firſt example, which I ſhall adduce to ſhew that both the primary and ſecondary parts of a train of irritative aſſociations of motion act with increaſed energy, is taken from the conſent of the ſkin with this organ. When the action of the fibres of the ſtomach is increaſed, as by the ſtimulus of a full meal, the exertions of the cutaneous arteries of the face become increaſed by their irritative aſſociations with thoſe of the ſtomach, and a glow or fluſhing of the face ſucceeds. For the ſmall veſſels of the ſkin of the face having been more accuſtomed to the varieties of action, from their frequent expoſure to various degrees of cold and heat, become more eaſily excited into increaſed action, than thoſe of the covered parts of our bodies, and thus act with more energy from their irritative or ſenſitive aſſociations with the ſtomach. On this account in ſmall-pox the eruption in conſequence of the previous affection of the ſtomach breaks out a day ſooner on the face than on the hands, and two days ſooner than on the trunk, and recedes in ſimilar times after maturation.

But ſecondly, in weaker conſtitutions, that is, in thoſe who poſſeſs leſs ſenſorial power, ſo much of it is expended in the increaſed actions of the fibres of the ſtomach excited by the ſtimulus of a meal, that a ſenſe of chilneſs ſucceeds inſtead of the univerſal glow above mentioned; and thus the ſecondary part of the aſſociated train of motions is diminiſhed in energy, in conſequence of the increaſed activity of the primary part of it.

2. Another inſtance of a ſimilar kind, where the ſecondary part of the train acts with leſs energy in conſequence of the greater exertions of the primary part, is the vertigo attending intoxication; in this circumſtance ſo much ſenſorial power is expended on the ſtomach, and on its neareſt or more ſtrongly aſſociated motions, as thoſe of the ſubcutaneous veſſels, and probably of the membranes of ſome internal viſcera, that the irritative motions of the retina become imperfectly exerted from deficiency of ſenſorial power, as explained in Sect. XX. and XXI. 3. on Vertigo and on Drunkenneſs, and hence the ſtaggering inebriate cannot completely balance himſelf by ſuch indiſtinct viſion.

3. An inſtance of the third circumſtance, where the primary part of a train of irritative motions acts with leſs, and the ſecondary part with greater energy, may be obſerved by making the following

experiment. If a perſon lies with his arms and ſhoulders out of bed, till they become cold, a temporary coryza or catarrh is produced; ſo that the paſſage of the noſtrils becomes totally obſtructed; at leaſt this happens to many people; and then on covering the arms and ſhoulders, till they become warm, the paſſage of the noſtrils ceaſes again to be obſtructed, and a quantity of mucus is diſcharged from them. In this caſe the quieſcence of the veſſels of the ſkin of the arms and ſhoulders, occaſioned by expoſure to cold air, produces by irritative aſſociation an increaſed action of the veſſels of the membrane of the noſtrils; and the accumulation of ſenſorial power during the torpor of the arms and ſhoulders is thus expended in producing a temporary coryza or catarrh.

Another inſtance may be adduced from the ſympathy or conſent of the motions of the ſtomach with other more diſtant links of the very extenſive tribes or trains of irritative motions aſſociated with them, deſcribed in Sect. XX. on Vertigo. When the actions of the fibres of the ſtomach are diminiſhed or inverted, the actions of the abſorbent veſſels, which take up the mucus from the lungs, pericardium, and other cells of the body, become increaſed, and abſorb the fluids accumulated in them with greater avidity, as appears from the exhibition of foxglove, antimony,

mony, or other emetics, in caſes of anaſarca, attended with unequal pulſe and difficult reſpiration.

That the act of nauſea and vomiting is a decreaſed exertion of the fibres of the ſtomach may be thus deduced; when an emetic medicine is adminiſtered, it produces the pain of ſickneſs, as a diſagreeable taſte in the mouth produces the pain of nauſea; theſe pains, like that of hunger, or of cold, or like thoſe, which are uſually termed nervous, as the head-ach or hemicrania, do not excite the organ into greater action; but in this caſe I imagine the pains of ſickneſs or of nauſea counteract or deſtroy the pleaſurable ſenſation, which ſeems neceſſary to digeſtion, as ſhewn in Sect. XXXIII. 1. 1. The periſtaltic motions of the fibres of the ſtomach become enfeebled by the want of this ſtimulus of pleaſurable ſenſation, and in conſequence ſtop for a time, and then become inverted; for they cannot become inverted without being previouſly ſtopped. Now that this inverſion of the trains of motion of the fibres of the ſtomach is owing to the deficiency of pleaſurable ſenſation is evinced from this circumſtance, that a nauſeous idea excited by words will produce vomiting as effectually as a nauſeous drug.

Hence it appears, that the act of nauſea or vomiting expends leſs ſenſorial power than the uſual periſtaltic motions of the ſtomach in the digeſtion of our aliment; and that hence there is a greater quantity of ſenſorial power becomes accumulated in the fibres of the ſtomach, and more of it in conſequence to ſpare for the action of thoſe parts of the ſyſtem, which are thus aſſociated with the ſtomach, as of the whole abſorbent ſeries of veſſels, and which are at the ſame time excited by their uſual ſtimuli.

From this we can underſtand, how after the operation of an emetic the ſtomach becomes more irritable and ſenſible to the ſtimulus, and the pleaſure of food; ſince as the ſenſorial power becomes accumulated during the nauſea and vomiting, the digeſtive power is afterwards exerted more forcibly for a time. It ſhould, however, be here remarked, that though vomiting is in general produced by the defect of this ſtimulus of pleaſurable ſenſation, as when a nauſeous drug is adminiſtered; yet in long-continued vomiting, as in ſea-ſickneſs, or from habitual dram-drinking, it ariſes from deficiency of ſenſorial power, which in the former caſe is exhauſted by the increaſed exertion of the irritative ideas of viſion, and in the latter by the frequent application of an unnatural ſtimulus.

4. An example of the fourth circumſtance above mentioned, where both the primary and ſecondary parts of a train of motions proceed with energy leſs than natural, may be obſerved in the dyſ-

pnœa, which occurs in going into a very cold bath, and which has been deſcribed and explained in Sect. XXXII. 3. 2.

And by the increaſed debility of the pulſations of the heart and arteries during the operation of an emetic. Secondly, from the ſlowneſs and intermiſſion of the pulſations of the heart from the inceſſant efforts to vomit occaſioned by an overdoſe of digitalis. And thirdly, from the total ſtoppage of the motions of the heart, or death, in conſequence of the torpor of the ſtomach, when affected with the commencement or cold paroxyſm of the gout. See Sect. XXV. 17.

II. 1. The primary and ſecondary parts of the trains of ſenſitive aſſociation reciprocally affect each other in different manners. 1. The increaſed ſenſation of the primary part may ceaſe, when that of the ſecondary part commences. 2. The increaſed action of the primary part may ceaſe, when that of the ſecondary part commences. 3. The primary part may have increaſed ſenſation, and the ſecondary part increaſed action. 4. The primary part may have increaſed action, and the ſecondary part increaſed ſenſation.

Examples of the firſt mode, where the increaſed ſenſation of the primary part of a train of ſenſitive aſſociation ceaſes, when that of the ſecondary part commences, are not unfrequent; as this is the general origin of thoſe pains, which continue ſome time without being attended with inflammation, ſuch as the pain at the pit of the ſtomach from a ſtone at the neck of the gall-bladder, and the pain of ſtrangury in the glans penis from a ſtone at the neck of the urinary bladder. In both theſe caſes the part, which is affected ſecondarily, is believed to be much more ſenſible than the part primarily affected, as deſcribed in the catalogue of diſeaſes, Claſs II. 1. 1. 11. and IV. 2. 2. 2. and IV. 2. 2. 4.

The hemicrania, or nervous head-ach, as it is called, when it originates from a decaying tooth, is another diſeaſe of this kind; as the pain of the carious tooth always ceaſes, when the pain over one eye and temple commences. And it is probable, that the violent pains, which induce convulſions in painful epilepſies, are produced in the ſame manner, from a more ſenſible part ſympathizing with a diſeaſed one of leſs ſenſibility. See Catalogue of diſeaſes, Claſs IV. 2. 2. 8. and III. 1. 1. 6.

The laſt tooth, or dens ſapientiæ, of the upper jaw moſt frequently decays firſt, and is liable to produce pain over the eye and temple of that ſide. The laſt tooth of the under jaw is alſo liable to produce a ſimilar hemicrania, when it begins to decay. When a tooth in the upper jaw is the cauſe of the headach, a ſlighter pain is ſometimes perceived on the cheek-bone. And when a tooth in the lower jaw is the cauſe of headach, a pain ſometimes affects the tendons of the muſcles of the neck, which are attached near the jaws. But the clavus hyſtericus, or pain about the middle of the parietal bone on one ſide of the head, I have ſeen produced by the ſecond of the molares, or grinders, of the under jaw; of which I ſhall relate the following caſe. See Claſs IV. 2. 2. 8.

Mrs. ——, about 30 years of age, was ſeized with great pain about the middle of the right parietal bone, which had continued a whole day before I ſaw her, and was ſo violent as to threaten to occaſion convulſions. Not being able to detect a decaying tooth, or a tender one, by examination with my eye, or by ſtriking them with a tea-ſpoon, and fearing bad conſequences from her tendency to convulſion, I adviſed her to extract the laſt tooth of the under-jaw on the affected ſide; which was done without any good effect. She was then directed to loſe blood, and to take a briſk cathartic; and after that had operated, about 60 drops of laudanum were given her, with large doſes of bark; by which the pain was removed. In about a fortnight ſhe took a cathartic medicine by ill advice, and the pain returned with greater violence in the ſame place; and, before I could arrive, as ſhe lived 30 miles from me, ſhe ſuffered a paralytic ſtroke; which affected her limbs and her face on one ſide, and relieved the pain of her head.

About a year afterwards I was again called to her on account of a pain, as violent as before, exactly on the ſame part of the other parietal bone. On examining her mouth I found the ſecond molaris of the under-jaw on the ſide before affected was now decayed, and concluded, that this tooth had occaſioned the ſtroke of the palſy by the pain and conſequent exertion it had cauſed. On this account I earneſtly entreated her to allow the ſound molaris of the ſame jaw oppoſite to the decayed one to be extracted; which was forthwith done, and the pain of her head immediately ceaſed, to the aſtoniſhment of her attendants.

In the caſes above related of the pain exiſting in a part diſtant from the ſeat of the diſeaſe, the pain is owing to defect of the uſual motions of the painful part. This appears from the coldneſs, paleneſs, and emptineſs of the affected veſſels, or of the extremities of the body in general, and from there being no tendency to inflammation. The increaſed action of the primary part of theſe aſſociated motions, as of the hepatic termination of the bile-duct from the ſtimulus of a gall-ſtone, or of the interior termination of the urethra from the ſtimulus of a ſtone in the bladder, or laſtly, of a decaying tooth in hemicrania, deprives the ſecondary part of theſe aſſociated motions, namely, the exterior terminations of the bile-duct or urethra, or the pained membranes of the head in hemicrania, of their natural ſhare of ſenſorial power: and hence the ſecondary parts of theſe ſenſitive trains of aſſociation become pained from the deficiency of their uſual motions, which is accompanied with deficiency of ſecretions and of heat. See Sect. IV. 5. XII. 5. 3. XXXIV. 1.

Why does the pain of the primary part of the aſſociation ceaſe, when that of the ſecondary part commences? This is a queſtion of intricacy, but perhaps not inexplicable. The pain of the primary part of theſe aſſociated trains of motion was owing to too great ſtimulus, as of the ſtone at the neck of the bladder, and was conſequently cauſed by too great action of the pained part. This greater action than natural of the primary part of theſe aſſociated motions, by employing or expending the ſenſorial power of irritation belonging to the whole aſſociated train of motions, occaſioned torpor, and conſequent pain in the ſecondary part of the aſſociated train; which was poſſeſſed of greater ſenſibility than the primary part of it. Now the great pain of the ſecondary part of the train, as ſoon as it commences, employs or expends the ſenſorial power of ſenſation belonging to the whole aſſociated train of motions; and in conſequence the motions of the primary part, though increaſed by the ſtimulus of an extraneous body, ceaſe to be accompanied with pain or ſenſation.

If this mode of reaſoning be juſt it explains a curious fact, why when two parts of the body are ſtrongly ſtimulated, the pain is felt only in one of them, though it is poſſible by voluntary attention it may be alternately perceived in them both. In the ſame manner, when two new ideas are preſented to us from the ſtimulus of external bodies, we attend to but one of them at a time. In other words, when one ſet of fibres, whether of the muſcles or organs of ſenſe, contract ſo ſtrongly as to excite much ſenſation; another ſet of fibres contracting more weakly do not excite ſenſation at all, becauſe the ſenſorial power of ſenſation is pre-occupied by the firſt ſet of fibres. So we cannot will more than one effect at once, though by aſſociations previouſly formed we can move many fibres in combination.

Thus in the inſtances above related, the termination of the bile duct in the duodenum, and the exterior extremity of the urethra, are more ſenſible than their other terminations. When theſe parts are deprived of their uſual motions by deficiency of ſenſorial power, as above explained, they become painful according to law the fifth in Section IV, and the leſs pain originally excited by the ſtimulus of concreted bile, or of a ſtone at their other extremities ceaſes to be perceived. Afterwards, however, when the concretions of bile, or the ſtone in the urinary bladder, become more numerous or larger, the pain from their increaſed ſtimulus becomes greater than the aſſociated pain; and is then felt at the neck of the gall bladder or urinary bladder; and the pain of the glans penis, or at the pit of the ſtomach, ceaſes to be perceived.

2. Examples of the ſecond mode, where the increaſed action of the primary part of a train of ſenſitive aſſociation ceaſes, when that of the ſecondary part commences, are alſo not unfrequent; as this is the uſual manner of the tranſlation of inflammations from internal to external parts of the ſyſtem, ſuch as when an inflammation of the liver or ſtomach is tranſlated to the membranes of the foot, and forms the gout; or to the ſkin of the face, and forms the roſy drop; or when an inflammation of the membranes of the kidneys is tranſlated to the ſkin of the loins, and forms one kind of herpes, called ſhingles; in theſe caſes by whatever cauſe the original inflammation may have been produced, as the ſecondary part of the train of ſenſitive aſſociation is more ſenſible, it becomes exerted with greater violence than the firſt part of it; and by both its increaſed pain, and the increaſed motion of its fibres, ſo far diminiſhes or exhauſts the ſenſorial power of ſenſation; that the primary part of the train being leſs ſenſible ceaſes both to feel pain, and to act with unnatural energy.

3. Examples of the third mode, where the primary part of a train of ſenſitive aſſociation of motions may experience increaſed ſenſation, and the ſecondary part increaſed action, are likewiſe not unfrequent; as it is in this manner that moſt

inflammations commence. Thus, after ſtanding ſome time in ſnow, the feet become affected with the pain of cold, and a common coryza, or inflammation of the membrane of the noſtrils, ſucceeds. It is probable that the internal inflammations, as pleuriſies, or hepatitis, which are produced after the cold paroxyſm of fever, originate in the ſame manner from the ſympathy of thoſe parts with ſome others, which were previouſly pained from quieſcence; as happens to various parts of the ſyſtem during the cold fits of fevers. In theſe caſes it would ſeem, that the ſenſorial power of ſenſation becomes accumulated during the pain of cold, as the torpor of the veſſels occaſioned by the defect of heat contributes to the increaſe or accumulation of the ſenſorial power of irritation, and that both theſe become exerted on ſome internal part, which was not rendered torpid by the cold which affected the external parts, nor by its aſſociation with them; or which ſooner recovered its ſenſibility. This requires further conſideration.

4. An example of the fourth mode, or where the primary part of a ſenſitive aſſociation of motions may have increaſed action, and the ſecondary part increaſed ſenſation, may be taken from the pain of the ſhoulder, which attends inflammation of the membranes of the liver, ſee Claſs IV. 2. 2. 9.; in this circumſtance ſo much ſenſorial power ſeems to be expended in the violent

actions and ſenſations of the inflamed membranes of the liver, that the membranes aſſociated with them become quieſcent to their uſual ſtimuli, and painful in conſequence.

There may be other modes in which the primary and ſecondary parts of the trains of aſſociated ſenſitive motions may reciprocally affect each other, as may be ſeen by looking over Claſs IV. in the catalogue of diſeaſes; all which may probably be reſolved into the plus and minus of ſenſorial power, but we have not yet had ſufficient obſervations made upon them with a view to this doctrine.

III. The aſſociated trains of our ideas may have ſympathies, and their primary and ſecondary parts affect each other in ſome manner ſimilar to thoſe above deſcribed; and may thus occaſion various curious phenomena not yet adverted to, beſides thoſe explained in the Sections on Dreams, Reveries, Vertigo, and Drunkenneſs; and may thus diſturb the deductions of our reaſonings, as well as the ſtreams of our imaginations; preſent us with falſe degrees of fear, attach unfounded value to trivial circumſtances; give occaſion to our early prejudices and antipathies; and thus embarraſs the happineſs of our lives. A copious and curious harveſt might be reaped from this province of ſcience, in which, however, I ſhall not at preſent wield my ſickle.

SECT. XXXVI.

OF THE PERIODS OF DISEASES.

I. *Muſcles excited by volition ſoon ceaſe to contract, or by ſenſation, or by irritation, owing to the exhauſtion of ſenſorial power. Muſcles ſubjected to leſs ſtimulus have their ſenſorial power accumulated. Hence the periods of ſome fevers. Want of irritability after intoxication.* II. 1. *Natural actions catenated with daily habits of life.* 2. *With ſolar periods. Periods of ſleep. Of evacuating the bowels.* 3. *Natural actions catenated with lunar periods. Menſtruation. Venereal orgaſm of animals. Barrenneſs.* III. *Periods of diſeaſed animal actions from ſtated returns of nocturnal cold, from ſolar and lunar influence. Periods of diurnal fever, hectic fever, quotidian, tertian, quartan fever. Periods of gout, pleuriſy, of fevers with arterial debility, and with arterial ſtrength. Periods of rhaphania, of nervous cough, hemicrania, arterial hæmorrhages, hæmorrhoids, hæmoptoe, epilepſy, palſy, apoplexy, madneſs.* IV. *Critical days depend on lunar periods. Lunar periods in the ſmall pox.*

I. If any of our muſcles be made to contract violently by the power of volition, as thoſe of the fingers, when any one hangs by his hands on a ſwing, fatigue ſoon enſues; and the muſcles ceaſe to act owing to the temporary exhauſtion of the ſpirit of animation; as ſoon as this is again accumulated in the muſcles, they are ready to contract again by the efforts of volition.

Thoſe violent muſcular actions induced by pain become in the ſame manner intermitted and recurrent; as in labour-pains, vomiting, teneſmus, ſtrangury; owing likewiſe to the temporary exhauſtion of the ſpirit of animation, as above mentioned.

When any ſtimulus continues long to act with unnatural violence, ſo as to produce too energetic action of any of our moving organs, thoſe motions ſoon ceaſe, though the ſtimulus continues to act; as in looking long on a bright object, as on an inch-ſquare of red ſilk laid on white paper in the ſunſhine. See Plate I. in Sect. III. 1.

On the contrary, where leſs of the ſtimulus of volition, ſenſation, or irritation, has been applied to a muſcle than uſual; there appears to be an accumulation of the ſpirit of animation in the moving organ; by which it is liable to act with greater energy from leſs quantity of ſtimulus, than was previouſly neceſſary to excite it into ſo great action; as after having been immerſed in ſnow the cutaneous veſſels of our hands are excited into ſtronger action by the ſtimulus of a leſs degree of heat, than would previouſly have produced that effect.

From hence the periods of ſome fever-fits may take their origin, either ſimply, or by their accidental coincidence with lunar and ſolar periods, or with the diurnal periods of heat and cold, to be treated of below; for during the cold fit at the commencement of a fever, from whatever cauſe that cold fit may have been induced, it follows, 1. That the ſpirit of animation muſt become accumulated in the parts, which exert during this cold fit leſs than their natural quantity of action. 2. If the cauſe producing the cold fit does not increaſe, or becomes diminiſhed; the parts before benumbed or inactive become now excitable by ſmaller ſtimulus, and are thence thrown into more violent action than is natural; that is a hot fit ſucceeds the cold one. 3. By the energetic action of the ſyſtem during the hot fit, if it continues long, an exhauſtion of the ſpirit of animation takes place; and another cold fit is liable to ſucceed, from the moving ſyſtem not being excitable into action from its uſual ſtimulus. This inirritability of the ſyſtem from a too great previous ſtimulus, and conſequent exhauſtion of ſenſorial power, is the cauſe of the general debility, and ſickneſs, and head-ach, ſome hours after intoxication. And hence we ſee one of the cauſes of the periods of fever-fits; which however are frequently combined with the periods of our diurnal habits, or of heat and cold, or of ſolar or lunar periods.

When beſides the tendency to quieſcence occaſioned by the expenditure of ſenſorial power during the hot fit of fever, ſome other cauſe of torpor, as the ſolar or lunar periods, is neceſſary to the introduction of a ſecond cold fit; the fever becomes of the intermittent kind; that is, there is a ſpace of time intervenes between the end of the hot fit, and the commencement of the next cold one. But where no exteriour cauſe is neceſſary to the introduction of the ſecond cold fit; no ſuch interval of health intervenes; but the ſecond cold fit commences, as ſoon as the ſenſorial power is ſufficiently exhauſted by the hot fit; and the fever becomes continual.

II. 1. The following are natural animal actions, which are frequently catenated with our daily habits of life, as well as excited by their natural irritations. The periods of hunger and thirſt become catenated with certain portions of time, or degrees of exhauſtion, or other diurnal habits of life. And if the pain of hunger be not relieved by taking food at the uſual time, it is liable to ceaſe till the next period of time or other habits recur; this is not only true in reſpect to our general deſire of food, but the kinds of it alſo are governed by this periodical habit; inſomuch that beer taken to breakfaſt will diſturb the digeſtion of thoſe, who have been accuſtomed to tea; and tea taken at dinner will diſagree with thoſe, who have been accuſtomed to beer. Whence it happens, that thoſe, who have weak ſtomachs, will be able to digeſt more food, if they take their meals at regular hours; becauſe they have both the ſtimulus of the aliment they take, and the periodical habit, to aſſiſt their digeſtion.

The periods of emptying the bladder are not only dependent on the acrimony or diſtention of the water in it, but are frequently catenated with external cold applied to the ſkin, as in cold bathing, or waſhing the hands; or with other habits of life, as many are accuſtomed to empty the bladder before going to bed, or into the houſe after a journey, and this whether it be full or not.

Our times of reſpiration are not only governed by the ſtimulus of the blood in the lungs, or our deſire of freſh air, but alſo by our attention to the hourly objects before us. Hence when a perſon is earneſtly contemplating an idea of grief, he forgets to breathe, till the ſenſation in his lungs becomes very urgent; and then a ſigh ſucceeds for the purpoſe of more forceably puſhing forwards the blood, which is accumulated in the lungs.

Our times of reſpiration are alſo frequently governed in part by our want of a ſteady ſupport for the actions of our arms, and hands, as in threading a needle, or hewing wood, or in ſwimming; when we are intent upon theſe objects, we breathe at the intervals of the exertion of the pectoral muſcles.

2. The following natural animal actions are influenced by ſolar periods. The periods of ſleep and of waking depend much on the ſolar period, for we are inclined to ſleep at a certain hour, and to awake at a certain hour, whether we have had more or leſs fatigue during the day, if within certain limits; and are liable to wake at a certain hour, whether we went to bed earlier or later, within certain limits. Hence it appears, that thoſe who complain of want of ſleep, will be liable to ſleep better or longer, if they accuſtom themſelves to go to reſt, and to riſe at certain hours.

The periods of evacuating the bowels are generally connected with ſome part of the ſolar day, as well as with the acrimony or diſtention occaſioned by the feces. Hence one method of correcting coſtiveneſs is by endeavouring to eſtabliſh a habit of evacuation at a certain hour of the day, as recommended by Mr. Locke, which may be accompliſhed by uſing daily voluntary efforts at thoſe times, joined with the uſual ſtimulus of the material to be evacuated.

3. The following natural animal actions are connected with lunar periods. 1. The periods of female menſtruation are connected with lunar periods to great exactneſs, in ſome inſtances even to a few hours. Theſe do not commence or terminate at the full or change, or at any other particular part of the lunation, but after they have commenced at any part of it, they continue to

recur at that part with great regularity, unleſs diſturbed by ſome violent circumſtance, as explained in Sect. XXXII. No. 6. their return is immediately cauſed by deficient venous abſorption, which is owing to the want of the ſtimulus, deſigned by nature, of amatorial copulation, or of the growing fetus. When the catamenia returns ſooner than the period of lunation, it ſhews a tendency of the conſtitution to irritability; that is to debility, or deficiency of ſenſorial power, and is to be relieved by ſmall doſes of ſteel and opium.

The venereal orgaſm of birds and quadrupeds ſeems to commence, or return about the moſt powerful lunations at the vernal or autumnal equinoxes; but if it be diſappointed of its object, it is ſaid to recur at monthly periods; in this reſpect reſembling the female catamenia. Whence it is believed, that women are more liable to become pregnant at or about the time of their catamenia, than at the intermediate times; and on this account they are ſeldom much miſtaken in their reckoning of nine lunar periods from the laſt menſtruation; the inattention to this may ſometimes have been the cauſe of ſuppoſed barrenneſs, and is therefore worth the obſervation of thoſe, who wiſh to have children.

III. We now come to the periods of diſeaſed animal actions. The periods of fever-fits, which depend on the ſtated returns of nocturnal cold, are diſcuſſed in Sect. XXXII. 3. Thoſe which originate or recur at ſolar or lunar periods, are alſo explained in Section XXXII. 6. Theſe we ſhall here enumerate; obſerving, however, that it is not more ſurpriſing, that the influence of the varying attractions of the ſun and moon, ſhould raiſe the ocean into mountains, than that it ſhould affect the nice ſenſibilities of animal bodies; though the manner of its operation on them is difficult to be underſtood. It is probable however, that as this influence gradually leſſens during the courſe of the day, or of the lunation, or of the year, ſome actions of our ſyſtem become leſs and leſs; till at length a total quieſcence of ſome part is induced; which is the commencement of the paroxyſms of fever, of menſtruation, of pain with decreaſed action of the affected organ, and of conſequent convulſion.

1. A diurnal fever in ſome weak people is diſtinctly obſerved to come on towards evening, and to ceaſe with a moiſt ſkin early in the morning, obeying the ſolar periods. Perſons of weak conſtitutions are liable to get into better ſpirits at the acceſs of the hot fit of this evening fever; and are thence inclined to ſit up late; which by further enfeebling them increaſes the diſeaſe; whence they loſe their ſtrength and their colour.

Hence delicate ladies, who do not uſe rouge, are obſerved to become paler in the evening;

which is probably owing to the circulation through the whole ſyſtem being leſs frequently performed in a given time, though the pulſe is quicker; and hence the maſs of blood becomes leſs frequently oxygenated in the lungs, and in conſequence has a leſs florid colour. This pale colour therefore ariſes from debility, which occurs to delicate people in the evening from the exhauſtion of ſenſorial power during the day, and is generally attended by quickneſs of pulſe; by which circumſtance the debility may in ſome degree be meaſured.

Another cauſe of the colour of the ſkin may occaſionally depend on the increaſed action of the cutaneous capillaries, as in the hot fit of fever; or by the production of new blood veſſels, as in topical inflammations. And paleneſs may ariſe from the contrary ſituations, as from inaction of the cutaneous capillaries in the cold paroxyſm of fever, and from the conerction of the ſides of the ſmall cutaneous arteries, as in old age.

2. The periods of hectic fever, ſuppoſed to ariſe from abſorption of matter, obey the diurnal periods like the above, having the exacerbeſcence towards evening, and the remiſſion early in the morning, with ſweats, or diarrhœa, or urine with white ſediment.

3. The periods of quotidian fever are either catenated with ſolar time, and return at the in-

tervals of twenty-four hours; or with lunar time, recurring at the intervals of about twenty-five hours. There is great uſe in knowing with what circumſtances the periodical return or new morbid motions are conjoined, as the moſt effectual times of exhibiting the proper medicines are thus determined. So if the torpor, which uſhers in an ague fit, is catenated with the lunar day; it is known when the bark or opium, muſt be given, ſo as to exert its principal effect about the time of the expected return. Solid opium ſhould be given about an hour before the expected cold fit; liquid opium and wine about half an hour; the bark repeatedly for ſix or eight hours previous to the expected return.

4. The periods of tertian fevers, reckoned from the commencement of one cold fit to the commencement of the next cold fit, recur with ſolar intervals of forty-eight hours, or with lunar ones of about fifty hours. When the recurrence of theſe begins one or two hours earlier than the ſolar period, it ſhews, that the torpor or cold fit is produced by leſs external influence; and therefore that it is more liable to degenerate into a fever with only remiſſions; ſo when menſtruation recurs ſooner than the period of lunation, it ſhews a tendency of the habit to torpor or inirritability.

5. The periods of quartan fevers return at ſolar intervals of ſeventy-two hours, or at lunar ones of about ſeventy-four hours and a half.

This kind of ague appears moſt in moiſt cold autumns, and in cold countries replete with marſhes. It is attended with greater debility, and its cold acceſs more difficult to prevent. For where there is previouſly a deficiency of ſenſorial power the conſtitution is liable to run into greater torpor from any further diminution of it; two ounces of bark and ſome ſteel ſhould be given on the day before the return of the cold paroxyſm, and a pint of wine by degrees a few hours before its return, and thirty drops of laudanum one hour before the expected cold fit.

6. The periods of the gout generally commence about an hour before ſun-riſe, which is uſually the coldeſt part of the twenty-four hours. The greater periods of the gout ſeem alſo to obſerve the ſolar influence, returning about the ſame ſeaſon of the year.

7. The periods of the pleuriſy recur with exacerbation of the pain and fever about ſun-ſet, at which time veneſection is of moſt ſervice. The ſame may be obſerved of the inflammatory rheumatiſm, and other fevers with arterial ſtrength, which ſeem to obey ſolar periods; and thoſe with debility ſeem to obey lunar ones.

8. The periods of fevers with arterial debility ſeem to obey the lunar day, having their acceſs daily nearly an hour later; and have ſometimes two acceſſes in a day, reſembling the lunar effects upon the tides.

9. The periods of rhaphania, or convulſions of the limbs from rheumatic pain, ſeem to be connected with ſolar influence, returning at nearly the ſame hour for weeks together, unleſs diſturbed by the exhibition of powerful doſes of opium.

So the periods of tuſſis ferina, or violent cough with ſlow pulſe, called nervous cough, recur by ſolar periods. Five grains of opium given at the time the cough commenced diſturbed the period, from ſeven in the evening to eleven, at which time it regularly returned for ſome days, during which time the opium was gradually omitted. Then 120 drops of laudanum were given an hour before the acceſs of the cough, and it totally ceaſed. The laudanum was continued a fortnight, and then gradually diſcontinued.

10. The periods of hemicrania, and of painful epilepſy, are liable to obey lunar periods, both in their diurnal returns, and in their greater periods of weeks, but are alſo induced by other exciting cauſes.

11. The periods of arterial hæmorrhages ſeem to return at ſolar periods about the ſame hour of the evening or morning. Perhaps the venous hæmorrhages obey the lunar periods, as the catamenia, and hæmorrhoids.

12. The periods of the hæmorrhoids, or piles, in ſome recur monthly, in others only at the greater lunar influence about the equinoxes.

13. The periods of hæmoptoe ſometimes obey ſolar influence, recurring early in the morning for ſeveral days; and ſometimes lunar periods, recurring monthly; and ſometimes depend on our hours of ſleep. See Claſs I. 2. 1. 9.

14. Many of the firſt periods of epileptic fits obey the monthly lunation with ſome degree of accuracy; others recur only at the moſt powerful lunations before the vernal equinox, and after the autumnal one; but when the conſtitution has gained a habit of relieving diſagreeable ſenſations by this kind of exertion, the fit recurs from any ſlight cauſe.

15. The attack of palſy and apoplexy are known to recur with great frequency about the equinoxes.

16. There are numerous inſtances of the effect of the lunations upon the periods of inſanity, whence the name of lunatic has been given to thoſe afflicted with this diſeaſe.

IV. The critical days, in which fevers are ſuppoſed to terminate, have employed the attention of medical philoſophers from the days of Hippocrates to the preſent time. In whatever part of a lunation a fever commences, which owes either its whole cauſe to ſolar and lunar influence, or to this in conjunction with other cauſes; it would ſeem, that the effect would be the greateſt at the full and new moon, as the tides riſe higheſt at thoſe times, and would be the leaſt at the quadratures; thus if a fever-fit ſhould commence at the new or full moon, occaſioned by the ſolar and lunar attraction diminiſhing ſome chemical affinity of the particles of blood, and thence decreaſing their ſtimulus on our ſanguiferous ſyſtem, as mentioned in Sect. XXXII. 6. this effect will daily decreaſe for the firſt ſeven days, and will then increaſe till about the fourteenth day, and will again decreaſe till about the twenty-firſt day, and increaſe again till the end of the lunation. If a fever-fit from the above cauſe ſhould commence on the ſeventh day after either lunation, the reverſe of the above circumſtances would happen. Now it is probable, that thoſe fevers, whoſe criſis or terminations are influenced by lunations, may begin at one or other of the above times, namely at the changes or quadratures; though ſufficient obſervations have not been made to aſcertain this circumſtance. Hence I conclude, that the ſmall-pox and meaſles have their critical days, not governed by the times required for certain chemical changes in the blood, which affect or alter the ſtimulus of the contagious matter, but from the daily increaſing or decreaſing effect of this lunar link of catenation, as explained in Section XVII, 3. 3. And as other fevers terminate moſt frequently about the ſeventh, fourteenth, twenty-firſt, or about the end of four weeks, when no medical aſſiſtance has diſturbed their periods, I conclude, that theſe criſes, or terminations, are governed by periods of the lunations, though we are ſtill ignorant of their manner of operation.

In the diſtinct ſmall-pox the veſtiges of lunation are very apparent; after inoculation a quarter of a lunation precedes the commencement of the fever, another quarter terminates with the complete eruption, another quarter with the complete maturation, and another quarter terminates the complete abſorption of a material now rendered inoffenſive to the conſtitution.

SECT. XXXVII.

OF DIGESTION, SECRETION, NUTRITION.

I. *Cryſtals increaſe by the greater attraction of their ſides. Accretion by chemical precipitations, by welding, by preſſure, by agglutination.* II. *Hunger, digeſtion, why it cannot be imitated out of the body. Lacteals abſorb by animal ſelection, or appetency.* III. *The glands and pores abſorb nutritious particles by animal ſelection. Organic particles of Buffon. Nutrition applied at the time of elongation of fibres. Like inflammation.* IV. *It ſeems eaſier to have preſerved animals than to reproduce them. Old age and death from inirritability. Three cauſes of this. Original fibres of the organs of ſenſe and muſcles unchanged.* V. *Art of producing long life.*

I. The larger cryſtals of ſaline bodies may be conceived to ariſe from the combination of ſmaller cryſtals of the ſame form, owing to the greater attractions of their ſides than of their angles. Thus if eight cubes were floating in a fluid, whoſe friction or reſiſtance is nothing, it is certain the ſides of theſe cubes would attract each other ſtronger than their angles; and hence that theſe eight ſmaller cubes would ſo arrange themſelves as to produce one larger one.

There are other means of chemical accretion, ſuch as the depoſitions of diſſolved calcareous or ſiliceous particles, as are ſeen in the formation of the ſtalactites of limeſtone in Derbyſhire, or of calcedone in Cornwall. Other means of adheſion are produced by heat and preſſure, as in the welding of iron-bars; and other means by ſimple preſſure, as in forcing two pieces of caoutchou, or elaſtic gum, to adhere; and laſtly, by the agglutination of a third ſubſtance penetrating the pores of the other two, as in the agglutination of wood by means of animal gluten. Though the ultimate particles of animal bodies are held together during life, as well as after death, by their ſpecific attraction of coheſion, like all other matter; yet it does not appear, that their original organization was produced by chemical laws, and their production and increaſe muſt therefore only be looked for from the laws of animation.

II. When the pain of hunger requires relief, certain parts of the material world, which ſurround us, when applied to our palates, excite into action the muſcles of deglutition; and the material is ſwallowed into the ſtomach. Here the new aliment becomes mixed with certain animal fluids, and undergoes a chemical proceſs, termed digeſtion; which, however, chemiſtry has not yet learnt to imitate out of the bodies of living animals or vegetables. This proceſs ſeems very ſimilar to the ſaccharine proceſs in the lobes of farinaceous ſeeds, as of barley, when it begins to germinate; except that, along with the ſugar, oil and mucilage are alſo produced; which form the chyle of animals, which is very ſimilar to their milk.

The reaſon, I imagine, why this chyle-making, or ſaccharine proceſs, has not yet been imitated by chemical operations, is owing to the materials being in ſuch a ſituation in reſpect to warmth, moiſture, and motion; that they will immediately change into the vinous or acetous fermentation; except the new ſugar be abſorbed by the numerous lacteal or lymphatic veſſels, as ſoon as it is produced; which is not eaſy to imitate in the laboratory.

Theſe lacteal veſſels have mouths, which are irritated into action by the ſtimulus of the fluid which ſurrounds them; and by animal ſelection, or appetency, they abſorb ſuch part of the fluid as is agreeable to their palate; thoſe parts, for inſtance, which are already converted into chyle, before they have time to undergo another change by a vinous or acetous fermentation. This animal abſorption of fluid is almoſt viſible to the naked eye in the action of the puncta lacrymalia; which imbibe the tears from the eye, and diſcharge them again into the noſtrils.

III. The arteries conſtitute another reſervoir of a changeful fluid; from which, after its recent oxygenation in the lungs, a further animal ſelection

tion of various fluids is abſorbed by the numerous glands; theſe ſelect their reſpective fluids from the blood, which is perpetually undergoing a chemical change; but the ſelection by theſe glands, like that of the lacteals, which open their mouths into the digeſting aliment in the ſtomach, is from animal appetency, not from chemical affinity; ſecretion cannot therefore be imitated in the laboratory, as it conſiſts in a ſelection of part of a fluid during the chemical change of that fluid.

The mouths of the lacteals, and lymphatics, and the ultimate terminations of the glands, are finer than can eaſily be conceived; yet it is probable, that the pores, or interſtices of the parts, or coats, which conſtitute theſe ultimate veſſels, may ſtill have greater tenuity; and that theſe pores from the above analogy muſt poſſeſs a ſimilar power of irritability, and abſorb by their living energy the particles of fluid adapted to their purpoſes, whether to replace the parts abraded or diſſolved, or to elongate and enlarge themſelves. Not only every kind of gland is thus endued with its peculiar appetency, and ſelects the material agreeable to its taſte from the blood, but every individual pore acquires by animal ſelection the material, which it wants; and thus nutrition ſeems to be performed in a manner ſo ſimilar to ſecretion; that they only differ in the one retaining, and the other parting again with the particles, which they have ſelected from the blood.

They may, indeed, differ in another circumſtance; that in nutrition certain particles of the circulating blood, which have not previouſly been uſed in the ſyſtem, are embraced, and form a ſolid part of the animal. Whereas in ſome of the ſecretions, thoſe particles appear to be imbibed by the glands, which have already been uſed in the ſyſtem, and probably abraded or detached from it into the circulation: theſe are depoſited in reſervoirs for future uſe, as bile and mucus; or excluded for other purpoſes, as ſemen and tears; or evacuated ſimply as feces and urine. And it ſhould be obſerved, that all theſe ſecretions are produced from their glands, in a very dilute ſtate, mingled, I believe, with mucus diſſolved in water; which is in part re-abſorbed from the reſervoirs of the glands, or from the cells or ſurfaces of the body, that no unneceſſary waſte of animal matter may occur; which accounts for the urinary bladders of fiſh, which would otherwiſe appear to be unneceſſary, according to the obſervation of Munro.

This way of accounting for nutrition from ſtimulus, and the conſequent animal ſelection of particles, is much more analogous to other phenomena of the animal microcoſm, than by having recourſe to the microſcopic animalcula, or organic particles of Buffon and Needham; which being already compounded muſt themſelves require nutritive particles to continue their own exiſtence. And muſt be liable to undergo a change by our digeſtive or ſecretory organs; otherwiſe mankind would ſoon reſemble by their theory the animals, which they feed upon. He, who is nouriſhed by beef or veniſon, would in time become horned; and he, who feeds on pork or bacon, would gain a noſe proper for rooting into the earth, as well as for the perception of odours.

The whole animal ſyſtem may be conſidered as conſiſting of the extremities of the nerves, or of having been produced from them; if we except perhaps the medullary part of the brain reſiding in the head and ſpine, and in the trunks of the nerves. Theſe extremities of the nerves are either of thoſe of locomotion, which are termed muſcular fibres; or of thoſe of ſenſation, which conſtitute the immediate organs of ſenſe, and which have alſo their peculiar motions. Now as the fibres, which conſtitute the bones and membranes, poſſeſſed originally ſenſation and motion; and are liable again to poſſeſs them, when they become inflamed; it follows, that thoſe were, when firſt formed, appendages to the nerves of ſenſation or locomotion, or were formed from them. And that hence all theſe ſolid parts of the body, as they have originally conſiſted of extremities of nerves, require an appoſition of nutritive particles of a ſimilar kind, contrary to the opinion of Buffon and Needham above recited.

Laſtly, as all theſe filaments have poſſeſſed, or do poſſeſs, the power of contraction, and of conſequent inertion or elongation; it ſeems probable, that the nutritive particles are applied during their times of elongation; when their original conſtituent particles are removed to a greater diſtance from each other. For each muſcular or ſenſual fibre may be conſidered as a row or ſtring of beads; which approach, when in contraction, and recede during its reſt or elongation; and our daily experience ſhews us, that great action emaciates the ſyſtem, and that it is repaired during reſt.

Something like this is ſeen out of the body; for if a hair, or a ſingle untwiſted fibre of flax or ſilk, be ſoaked in water; it becomes longer and thicker by the water, which is abſorbed into its pores. Now if a hair could be ſuppoſed to be thus immerſed in a ſolution of particles ſimilar to thoſe, which compoſe it; one may imagine, that it might be thus increaſed in weight and magnitude; as the particles of oak-bark increaſe the ſubſtance of the hides of beaſts in the proceſs of making leather. I mention theſe not as philoſophic analogies, but as ſimiles to facilitate our ideas, how an accretion of parts may be effected by animal appetences, or ſelections, in a manner ſomewhat ſimilar to mechanical or chemical attractions.

If thoſe new particles of matter, previouſly prepared by digeſtion and ſanguification, only ſupply the places of thoſe, which have been abraded by the actions of the ſyſtem, it is properly termed nutrition. If they are applied to the extremities of the nervous fibrils, or in ſuch quantity as to increaſe the length or craſſitude of them, the body becomes at the ſame time enlarged, and its growth is increaſed, as well as its deficiences repaired.

In this laſt caſe ſomething more than a ſimple appoſition or ſelection of particles ſeems to be neceſſary; as many parts of the ſyſtem during its growth are cauſed to recede from thoſe, with which they were before in contact; as the ends of the bones, or cartilages, recede from each other, as their growth advances: this proceſs reſembles inflammation, as appears in ophthalmy, or in the production of new fleſh in ulcers, where old veſſels are enlarged, and new ones produced; and like that is attended with ſenſation. In this ſituation the veſſels become diſtended with blood, and acquire greater ſenſibility, and may thus be compared to the erection of the penis, or of the nipples of the breaſts of women; while new particles become added at the ſame time; as in the proceſs of nutrition above deſcribed.

When only the natural growth of the various parts of the body is produced, a pleaſurable ſenſation attends it, as in youth, and perhaps in thoſe, who are in the progreſs of becoming fat. When an unnatural growth is the conſequence, as in inflammatory diſeaſes, a painful ſenſation attends the enlargement of the ſyſtem.

IV. This appoſition of new parts, as the old ones diſappear, ſelected from the aliment we take, firſt enlarges and ſtrengthens our bodies for twenty years; for another twenty years it keeps us in health and vigour, and adds ſtrength and ſolidity to the ſyſtem, and then gradually ceaſes to nouriſh us properly; and for another twenty years we gradually ſink into decay, and finally ceaſe to act, and to exiſt.

On conſidering this ſubject one ſhould have imagined at firſt view, that it might have been eaſier for nature to have ſupported her progeny for ever in health and life, than to have perpetually reproduced them by the wonderful and myſterious proceſs of generation. But it ſeems our bodies by long habit ceaſe to obey the ſtimulus of the aliment, which ſhould ſupport us. After we have acquired our height and ſolidity we make no more new parts, and the ſyſtem obeys the irritations, ſenſations, volitions, and aſſociations, with leſs and leſs energy, till the whole ſinks into inaction.

Three cauſes may conſpire to render our nerves leſs excitable, which have been already mentioned.

tioned. 1. If a ſtimulus be greater than natural, it produces too great an exertion of the ſtimulated organ, and in conſequence exhauſts the ſpirit of animation; and the moving organ ceaſes to act, even though the ſtimulus be continued. And though reſt will recruit this exhauſtion, yet ſome degree of permanent injury remains, as is evident after expoſing the eyes long to too ſtrong a light. 2. If excitations weaker than natural be applied, ſo as not to excite the organ into action, (as when ſmall doſes of aloes or rhubarb are exhibited,) they may be gradually increaſed, without exciting the organ into action; which will thus acquire a habit of diſobedience to the ſtimulus; thus by increaſing the doſe by degrees, great quantities of opium or wine may be taken without intoxication. See Sect. XII. 3. 1.

3. Another mode, by which life is gradually undermined, is when irritative motions continue to be produced in conſequence of ſtimulus, but are not ſucceeded by ſenſation; hence the ſtimulus of contagious matter is not capable of producing fever a ſecond time, becauſe it is not ſucceeded by ſenſation. See Sect. XII. 3. 6. And hence, owing to the want of the general pleaſurable ſenſation, which ought to attend digeſtion and glandular ſecretion, an irkſomeneſs of life enſues; and, where this is in greater exceſs, the melancholy of old age occurs, with torpor or debility.

From hence I conclude, that it is probable that the fibrillæ, or moving filaments at the extremities of the nerves of ſenſe, and the fibres which conſtitute the muſcles (which are perhaps the only parts of the ſyſtem that are endued with contractile life) are not changed, as we advance in years, like the other parts of the body; but only enlarged or elongated with our growth; and in conſequence they become leſs and leſs excitable into action. Whence, inſtead of gradually changing the old animal, the generation of a totally new one becomes neceſſary with undiminiſhed excitability; which many years will continue to acquire new parts, or new ſolidity, and then loſing its excitability in time, periſh like its parent.

V. From this idea the art of preſerving long health and life may be deduced; which muſt conſiſt in uſing no greater ſtimulus, whether of the quantity or kind of our food and drink, or of external circumſtances, ſuch as heat, and exerciſe, and wakefulneſs, than is ſufficient to preſerve us in vigour; and gradually, as we grow old to increaſe the ſtimulus of our aliment, as the inirritability of our ſyſtem increaſes.

The debilitating effects aſcribed by the poet Martial to the exceſſive uſe of warm bathing in Italy, may with equal propriety be applied to the warm rooms of England; which, with the general exceſſive ſtimulus of ſpirituous or fermented liquors, and in ſome inſtances of immoderate venery, contribute to ſhorten our lives.

Balnea, vina, Venus, corrumpunt corpora noſtra:
At faciunt vitam balnea, vina, Venus!

Wine, women, warmth, againſt our lives combine;
But what is life, without warmth, women, wine!

SECT. XXXVIII.

OF THE OXYGENATION OF THE BLOOD IN THE LUNGS, AND IN THE PLACENTA.

I. *Blood abſorbs oxygene from the air, whence phoſphoric acid, changes its colour, gives out heat, and ſome phlogiſtic material, and acquires an ethereal ſpirit, which is diſſipated in fibrous motion.* II. *The placenta is a pulmonary organ like the gills of fiſh. Oxygenation of the blood from air, from water, by lungs, by gills, by the placenta; neceſſity of this oxygenation to quadrupeds, to fiſh, to the fetus in utero. Placental veſſels inſerted into the arteries of the mother. Uſe of cotyledons in cows. Why quadrupeds have not ſanguiferous lochia. Oxygenation of the chick in the egg, of ſeeds.* III. *The liquor amnii is not excrementitious. It is nutritious. It is found in the eſophagus and ſtomach, and forms the meconium. Monſtrous births without heads. Queſtion of Dr. Harvey.*

I. From the recent diſcoveries of many ingenious philoſophers it appears, that during reſpiration the blood imbibes the vital part of the air, called oxygene, through the membranes of the lungs; and that hence reſpiration may be aptly compared to a ſlow combuſtion. As in combuſtion the oxygene of the atmoſphere unites with ſome phlogiſtic or inflammable body, and forms an acid (as in the production of vitriolic acid from ſulphur, or carbonic acid from charcoal,) giving out at the ſame time a quantity of the matter of heat; ſo in reſpiration the oxygene of the air unites with the phlogiſtic part of the blood, and probably produces phoſphoric or animal acid, changing the colour of the blood from a dark to a bright red; and probably ſome of the matter of heat is at the ſame time given out according to the theory of Dr. Crawford. But as the evolution of heat attends almoſt all chemical combinations, it is probable, that it alſo attends the ſecretions of the various fluids from the blood; and that the conſtant combinations or productions of new fluids by means of the glands conſtitute the more general ſource of animal heat; this ſeems evinced by the univerſal evolution of the matter of heat in the bluſh of ſhame or of anger; in which at the ſame time an increaſed ſecretion of the perſpirable matter occurs; and the partial evolution of it from topical inflammations, as in gout or rheumatiſm, in which there is a ſecretion of new blood-veſſels.

Some medical philoſophers have aſcribed the heat of animal bodies to the friction of the particles of the blood againſt the ſides of the veſſels. But no perceptible heat has ever been produced by the agitation of water, or oil, or quickſilver, or other fluids; except thoſe fluids have undergone at the ſame time ſome chemical change, as in agitating milk or wine, till they become ſour.

Beſides the ſuppoſed production of phoſphoric acid, and change of colour of the blood, and the production of carbonic acid, there would appear to be ſomething of a more ſubtile nature perpetually acquired from the atmoſphere; which is too fine to be long contained in animal veſſels, and therefore requires perpetual renovation; and without which perfect life cannot continue longer than a minute or two; this ethereal fluid is probably ſecreted from the blood by the brain, and perpetually diſſipated in the actions of the muſcles and organs of ſenſe, but which nevertheleſs may remain for a longer time, where there is little or no exertion of the animal fibres, as in ſyncope, and in thoſe inſects and other animals, which remain during the winter in a torpid ſtate, and may not entirely evaporate from defect of warmth, or moiſture, or other circumſtances, as ſnails are ſaid to have revived after having been many years in a dry cabinet, and flies after having been many months drowned in wine, and other inſects after having been frozen.

That the blood acquires ſomething from the air, which is immediately neceſſary to life, appears from an experiment of Dr. Hare, (Philoſ. Tranſact. abridged, Vol. III. p. 239.) who found, "that birds, mice, &c. would live as long again in a veſſel, where he had crowded in double the quantity of air by a condenſing engine, than they did when confined in air of the common denſity." Whereas if ſome kind of deleterious vapour only was exhaled from the blood in reſpiration; the air, when condenſed into half its compaſs, could not be ſuppoſed to receive ſo much of it.

II. Sir Edward Hulſe, a phyſician of reputation at the beginning of the preſent century, was of opinion, that the placenta was a reſpiratory organ, like the gills of fiſh; and not an organ to ſupply nutriment to the fœtus; as mentioned in Derham's Phyſico-theology. Many other phyſicians ſeem to have eſpouſed the ſame opinion, as noticed by Haller. Elem. Phyſiologiæ, T. 1. Dr. Gipſon publiſhed a defence of this theory in the Medical Eſſays of Edinburgh, Vol. I. and II. which doctrine is there controverted at large by the late Alexander Monro; and ſince that time the general opinion has been, that the placenta is an organ of nutrition only, owing perhaps rather to the authority of ſo great a name, than to the validity of the arguments adduced in its ſupport. The ſubject has lately been reſumed by Dr. James Jeffray, and by Dr. Foreſter French, in their inaugural diſſertations at Edinburgh and at Cambridge; who have defended the contrary opinion in an able and ingenious manner; and from whoſe Theſes I have extracted many of the following remarks.

Firſt, by the late diſcoveries of Dr. Prieſtley, M. La-

M. Lavoiſier, and other philoſophers, it appears, that the baſis of atmoſpherical air, called oxygene, is received by the blood through the membranes of the lungs; and that by this addition the colour of the blood is changed from a dark to a light red. Secondly, that water poſſeſſes oxygene alſo as a part of its compoſition, and contains air likewiſe in its pores; whence the blood of fiſh receives oxygene from the water, or from the air it contains, by means of their gills, in the ſame manner as the blood is oxygenated in the lungs of air-breathing animals; it changes its colour at the ſame time from a dark to a light red in the veſſels of their gills, which conſtitute a pulmonary organ adapted to the medium in which they live. Thirdly, that the placenta conſiſts of arteries carrying the blood to its extremities, and a vein bringing it back, reſembling exactly in ſtructure the lungs and gills above mentioned; and that the blood changes its colour from a dark to a light red in paſſing through theſe veſſels.

This analogy between the lungs and gills of animals, and the placenta of the fetus, extends through a great variety of other circumſtances; thus air-breathing creatures and fiſh can live but a few minutes without air or water; or when they are confined in ſuch air or water, as has been ſpoiled by their own reſpiration; the ſame happens to the fetus, which, as ſoon as the placenta is ſeparated from the uterus, muſt either expand its lungs, and receive air, or die. Hence from the ſtructure, as well as the uſe of the placenta, it appears to be a reſpiratory organ, like the gills of fiſh, by which the blood in the fetus becomes oxygenated.

From the terminations of the placental veſſels not being obſerved to bleed after being torn from the uterus, while thoſe of the uterus effuſe a great quantity of florid arterial blood, the terminations of the placental veſſels would ſeem to be inſerted into the arterial ones of the mother; and to receive oxygenation from the paſſing currents of her blood through their coats or membranes; which oxygenation is proved by the change of the colour of the blood from dark to light red in its paſſage from the placental arteries to the placental vein.

The curious ſtructure of the cavities or lacunæ of the placenta, demonſtrated by Mr. J. Hunter, explains this circumſtance. That ingenious philoſopher has ſhewn, that there are numerous cavities or lacunæ formed on that ſide of the placenta, which is in contact with the uterus; thoſe cavities or cells are filled with blood from the maternal arteries, which open into them; which blood is again taken up by the maternal veins, and is thus perpetually changed. While the terminations of the placental arteries and veins are ſpread in fine reticulation on the ſides of theſe cells. And thus, as the growing fetus requires greater oxygenation, an apparatus is produced reſembling exactly the air-cells of the lungs.

In cows, and other ruminating animals, the internal ſurface of the uterus is unequal like hollow cups, which have been called cotyledons; and into theſe cavities the prominencies of the numerous placentas, with which the fetus of thoſe animals is furniſhed, are inſerted, and ſtrictly adhere; though they may be extracted without effuſion of blood. Theſe inequalities of the uterus, and the numerous placentas in conſequence, ſeem to be deſigned for the purpoſe of expanding a greater ſurface for the terminations of the placental veſſels for the purpoſe of receiving oxygenation from the uterine ones; as the progeny of this claſs of animals are more completely formed before their nativity, than that of the carnivorous claſſes, and muſt thence in the latter weeks of pregnancy require greater oxygenation. Thus calves and lambs can walk about in a few minutes after their birth; while puppies and kittens remain many days without opening their eyes. And though on the ſeparation of the cotyledons of ruminating animals no blood is effuſed, yet this is owing clearly to the greater power of contraction of their uterine lacunæ or alveoli. See Medical Eſſays, Vol. V. page 144. And from the ſame cauſe they are not liable to a ſanguiſerous menſtruation.

The neceſſity of the oxygenation of the blood in the fetus is farther illuſtrated by the analogy of the chick in the egg; which appears to have its blood oxygenated at the extremities of the veſſels ſurrounding the yolk; which are ſpread on the air-bag at the broad end of the egg, and may abſorb oxygene through that moiſt membrane from the air confined behind it; and which is ſhewn by experiments in the exhauſted receiver to be changeable though the ſhell. See Phytologia, Sect. III.

This analogy may even be extended to the growing ſeeds of vegetables; which were ſhewn by Mr. Scheele to require a renovation of the air over the water, in which they were confined. Many vegetable ſeeds are ſurrounded with air in their pods or receptacles, as peas, the fruit of ſtaphylea, and lichnis veſicaria; but it is probable, that thoſe ſeeds, after they are ſhed, as well as the ſpawn of fiſh, by the ſituation of the former on or near the moiſt and aerated ſurface of the earth, and of the latter in the ever-changing and ventilated water, may not be in need of an apparatus for the oxygenation of their firſt blood, before the leaves of one, and the gills of the other, are produced for this purpoſe. See Phytologia, Sect. III.

III. 1. There are many arguments, beſides the ſtrict analogy between the liquor amnii and the albumen ovi, which ſhew the former to be a nutritive fluid; and that the ſetus in the latter months of pregnancy takes it into its ſtomach; and that in conſequence the placenta is produced for ſome other important purpoſe.

Firſt, that the liquor amnii is not an excrementitious fluid is evinced, becauſe it is found in greater quantity, when the ſetus is young, decreaſing after a certain period till birth. Haller aſſerts, "that in ſome animals but a ſmall quantity of this fluid remains at the birth. In the eggs of hens it is conſumed on the eighteenth day, ſo that at the excluſion of the chick ſcarcely any remains. In rabbits before birth there is none." Elem. Phyſiol. Had this been an excrementitious fluid, the contrary would probably have occurred. Secondly, the ſkin of the ſetus is covered with a whitiſh cruſt or pellicle, which would ſeem to preclude any idea of the liquor amnii being produced by any exſudation of perſpirable matter. And it cannot conſiſt of urine, becauſe in brute animals the urachus paſſes from the bladder to the alantois for the expreſs purpoſe of carrying off that fluid; which however in the human ſetus ſeems to be retained in the diſtended bladder, as the feces are accumulated in the bowels of all animals.

2. The nutritious quality of the liquid, which ſurrounds the ſetus, appears from the following conſiderations. 1. It is coagulable by heat, by nitrous

May not this be from absorption

nitrous acid, and by ſpirit of wine, like milk, ſerum of blood, and other fluids, which daily experience evinces to be nutritious. 2. It has a ſaltiſh taſte according to the accurate Baron Haller, not unlike the whey of milk, which it even reſembles in ſmell. 3. The white of the egg which conſtitutes the food of the chick, is ſhewn to be nutritious by our daily experience; beſides the experiment of its nutritious effects mentioned by Dr. Fordyce in his late Treatiſe on Digeſtion, p. 178; who adds, that it much reſembles the eſſential parts of the ſerum of blood.

3. A fluid ſimilar to the fluid, with which the fetus is ſurrounded, except what little change may be produced by a beginning digeſtion, is found in the ſame manner in the ſtomach of the chick.

Numerous hairs, ſimilar to thoſe of its ſkin, are perpetually found among the contents of the ſtomach in new-born calves; which muſt therefore have licked themſelves before their nativity. Blaſii Anatom. See Sect. XVI. 2. on Inſtinct.

The chick in the egg is ſeen gently to move in its ſurrounding fluid, and to open and ſhut its mouth alternately. The ſame has been obſerved in puppies. Haller's El. Phyſ. I. 8. p. 201.

A column of ice has been ſeen to reach down the œſophagus from the mouth to the ſtomach in a frozen fetus; and this ice was the liquor amnii frozen.

The meconium, or firſt feces, in the bowels of new-born infants evince, that ſomething has been digeſted; and what could this be but the liquor amnii together with the recrements of the gaſtric juice and gall, which were neceſſary for its digeſtion?

Another argument to evince, that the fetus is nouriſhed by aliment taken into the ſtomach and inteſtines by the mouth during the latter months of pregnancy, may be deduced from the liver of the fetus; which Haller obſerves to be very large; not like the lungs, as if deſigned for the future man after nativity. Phyſiol. Vol. VI. p. 618. Whence a ſecretion of bile muſt already exiſt, which can ſerve no purpoſe but to be mixed with the digeſting aliment.

There have been recorded ſome monſtrous births of animals without heads, and conſequently without mouths, which ſeem to have been delivered on doubtful authority, or from inaccurate obſervation. There are two of ſuch monſtrous productions however better atteſted; one of a human fetus, mentioned by Gipſon in the Scots Medical Eſſays; which having the gula impervious was furniſhed with an aperture into the wind-pipe, which communicated below into the gullet; by means of which the liquor amnii might be taken into the ſtomach before nativity without danger of ſuffocation, while the fetus had no occaſion to breathe. The other monſtrous fetus is deſcribed by Vander Wiel, who aſſerts that he ſaw a monſtrous lamb, which had no mouth; but inſtead of it was furniſhed with an opening in the lower part of the neck into the ſtomach. Both theſe inſtances evidently favour the doctrine of the fetus being nouriſhed by the mouth; as otherwiſe there had been no neceſſity for new or unnatural apertures into the ſtomach, when the natural ones were deficient.

From theſe facts and obſervations we may ſafely infer, that the fetus in the womb is nouriſhed by the fluid which ſurrounds it; which during the firſt period of geſtation is abſorbed by the naked lacteals; and is afterwards ſwallowed into the ſtomach and bowels, when theſe organs are perfected; and laſtly that the placenta is an organ for the purpoſe of giving due oxygenation to the blood of the fetus; which is more neceſſary, or at leaſt more frequently neceſſary, than even the ſupply of food.

The queſtion of the great Harvey becomes thus eaſily anſwered. "Why is not the fetus in the womb ſuffocated for want of air, when it remains there even to the tenth month without reſpiration: yet if it be born in the ſeventh or eighth month, and has once reſpired, it becomes immediately ſuffocated for want of air, if its reſpiration be obſtructed?"

For

No such thing as [illegible] [illegible]
ever been found in the [illegible] [illegible]
and wholly [illegible] of [illegible] [illegible]

For further information on this ſubject, the reader is referred to the Tentamen Medicum of Dr. Jeffray, printed at Edinburgh in 1786. And it is hoped that Dr. Foreſter will ſome time give his theſes on this ſubject to the public.

SECT. XXXIX.

OF GENERATION.

> Felix, qui cauſas altâ caligine merſas
> Pandit, et evolvit tenuiſſima vincula rerum. Anon.

I. *Habits of acting and feeling of individuals attend the ſoul into a future life, and attend the new embryon at the time of its production. The new ſpeck of entity abſorbs nutriment, and receives oxygene. Spreads the terminations of its veſſels on cells, which communicate with the arteries of the uterus; ſometimes with thoſe of the peritoneum. Afterwards it ſwallows the liquor amnii, which it produces by its irritation from the uterus, or peritoneum. Like inſects in the heads of calves and ſheep. Why the white of egg is of two conſiſtencies. Why nothing is found in quadrupeds ſimilar to the yolk, nor in moſt vegetable ſeeds.* II. 1. *Eggs of frogs and fiſh impregnated out of their bodies. Eggs of fowls which are not fecundated, contain only the nutriment for the embryon. The embryon is produced by the male, and the nutriment by the female. Animalcula in ſemine. Profuſion of nature's births.* 2. *Vegetables viviparous. Buds and bulbs have each a father but no mother. Veſſels of the leaf and bud inoſculate. The paternal offſpring exactly reſembles the parent.* 3. *Inſects impregnated for ſix generations. Polypus branches like buds. Creeping roots. Viviparous flowers. Tænia, volvox. Eve from Adam's rib. Semen not a ſtimulus to the egg.* III. 1. *Embryons not originally created within other embryons. Organized*

ganized matter is not ſo minute. 2. All the parts of the embryon are not formed in the male parent. Crabs produce their legs, worms produce their heads and tails. In wens, cancers, and inflammations, new veſſels are formed. Mules partake of the forms of both parents. Hair and nails grow by elongation, not by diſtention. 3. Organic particles of Buffon. IV. 1. *Rudiment of the embryon a ſimple living filament, becomes a living ring, and then a living tube. 2. It acquires new irritabilities, and ſenſibilities with new organizations, as in wounded ſnails, polypi, moths, gnats, tadpoles. Hence new parts are acquired by addition not by diſtention. 3. All parts of the body grow if not confined. 4. Fetuſes deficient at their extremities, or have a duplicature of parts. Monſtrous births. Double parts of vegetables. 5. Mules cannot be formed by diſtention of the ſeminal ens. 6. Families of animals from a mixture of their orders. Mules imperfect. 7. Animal appetency like chemical affinity. Vis fabricatrix and medicatrix of nature. 8. The changes of animals before and after nativity. Similarity of their ſtructure. Changes in them from luſt, hunger, and danger. All warm-blooded animals derived from one living filament. Cold-blooded animals, inſects, worms, vegetables, derived alſo from one living filament. Male animals have teats. Male pigeon gives milk. The world itſelf generated. The cauſe of cauſes. A ſtate of probation and reſponſibility.* V. 1. *Efficient cauſe of the colours of birds eggs, and of hair and feathers, which become white in ſnowy countries. Imagination of the female colours the egg. Ideas or motions of the retina imitated by the extremities of the nerves of touch, or rete mucoſum. 2. Nutriment ſupplied by the female of three kinds. Her imagination can only affect the firſt kind. Mules how produced, and mulattoes. Organs of reproduction why deficient in mules. Eggs with double yolks.* VI. 1. *Various ſecretions pro-*

duced by the extremities of the veſſels, as in the glands. Contagious matter. Many glands affected by pleaſurable ideas, as thoſe which ſecrete the ſemen. 2. *Snails and worms are hermaphrodite, yet cannot impregnate themſelves. Final cauſe of this.* 3. *The imagination of the male forms the ſex. Ideas, or motions of the nerves of viſion or of touch, are imitated by the ultimate extremities of the glands of the teſtes, which mark the ſex. This effect of the imagination belongs only to the male. The ſex of the embryon is not owing to accident.* 4. *Cauſes of the changes in animals from imagination as in monſters. From the male. From the female.* 5. *Miſcarriages from fear.* 6. *Power of the imagination of the male over the colour, form, and ſex of the progeny. An inſtance of.* 7. *Act of generation accompanied with ideas of the male or female form. Art of begetting beautiful children of either ſex.* VII. *Recapitulation.* VIII. 1. *Appendix. Buds are individuals. Conſiſt of plumula caudex and radicle. Every part of the caudex can germinate. A triple tree by ingraftment. A lateral vegetable mule produced by three parents. Conferva fontinalis.* 2. *Lateral propagation of polypus, and hydra ſtentorea. The halves of two polypi made to unite. Ingraftment of vegetables. Lateral mule.* 3. *New bud of a doubly ingrafted tree has three kinds of caudex. Triple mule produced from various parts of the parent tree.* 4. *Earthworms cut aſunder generate a new head, and a new tail. So the caudexes of the buds of trees. The whole embryon not formed at the ſame time.* 5. *Parts of the long caudex of the new bud are ſecreted from correſpondent parts of the parent bud, and unite beneath the cuticle. Every part of the caudex can germinate. Theſe new buds reſemble the part of the ſtock, where they ariſe. Lateral mule from many parents. If a triple ſexual mule?* 6. *Gravitation, chemical affinity, electricity, magnetiſm. Power to attract. Aptitude to be attracted.*

attracted. A magnet poſſeſſes power to attract, iron an aptitude to be attracted. So of electrified bodies, and chemical affinities. Or two bodies may reciprocally attract each other. 7. *Union of animal with inanimate matter. Union of two living particles. The animal ſenſe poſſeſſes appetency to unite, the inanimate material poſſeſſes aptitude to be united. Vitality of the blood. Fibrils with appetencies, molecules with propenſities.* 8. *Fibrils with formative appetencies. Molecules with formative propenſities. Like ſingle and double affinities. Paſſions of hunger and of love. Thirſt. Suckling children. Mode of lateral propagation.* 9. *Superfluous vital particles produced in the blood. Secreted by ſexual glands. Combine beneath the cuticle of trees. Acquire new appetencies, and form ſecondary parts of the embryon. So the paſſion for generation, and deſire for animal food, and the new attractions of bodies chemically combined. New molecules are formed by the ſexual glands at puberty, and in the pectoral ones.* 10. *Different fibrils and molecules are detached from different parts of the parent caudex to form the filial one: ſo in the ſexual propagation of vegetables: and by their combination produce an embryon, and acquire new appetencies and form ſecondary parts, as in dioecious flowers.* 11. *Threefold lateral mules. So ſexual mules reſemble parts of their parents according to the combinations of the fibrils and molecules, and produce ſecondary parts, otherwiſe they would reſemble the father only. Epigram from Martial.* IX. 1. *Various parts of the new embryon produced at the ſame time. Organized bodies too large to be ſecreted. Primary and ſecondary formation of parts of the fetus. M. Buffon's theory differs from this. Moles and monſtrous births. An embryon is not an individual, till the nerves unite in the brain.* 2. *The brain and heart generated at the ſame time.* 3. *Organic particles too large to paſs the glands and capillaries. Not ſo the* *formative particles. Hence the latter cannot combine in the blood. 4. Formative particles do not combine in the receptacles of the ſexual glands, as thoſe of the male differ from thoſe of the female. Not ſo in Buffon's theory. 5. The whole embryon not produced at the ſame time. Primary and ſecondary parts. Secondary formation of the caudex of buds, of diſſevered earth worms, of the legs of crabs, of human teeth, and of a thumb.* X. 1. *Solitary lateral generation, and ſolitary internal generation. Animalized particles of primary combination, are ſeſecreted, combine, and form primary organizations. The caudex gemmæ produces ſecondary parts, and commences its formation in ſeveral places at the ſame time. Reſembles the parent more than a ſexual progeny. The polypus and hydra.* 2. *Solitary internal generation of aphis, tenia, actinia, volvox, produces a viviparous offspring, not an oviparous one. Difference of lateral and internal generation.* 3. *Hermaphrodite ſexual generation in moſt flowers, and ſome inſects. Summit-bulbs of ſome vegetables are a ſexual progeny. Sexual organs in hermaphrodites are ſeparate, but ſecrete the maſculine and feminine formative particles from the ſame maſs of blood. Why ſeedling apple-trees ſometimes reſemble the parent, ſometimes not. Number of ſpecies increaſed by reciprocal generation.* 4. *In ſimple ſexual generation the maſculine and feminine ſecretions are from different maſſes of blood. Theſe animals were originally hermaphrodites. The mode of the production of the new embryon. Secretion differs from nutrition. New embryon begins in more parts than one. Acquires new appetencies, and fabricates ſecondary parts. Sexual organs are ſecondary parts, not primary ones. So is the difference of the male and female forms. Vegetable and animal ſecondary productions.* 5. *Seeds. Eggs. Spawn differs from eggs, as it enlarges along with the embryon like the*

the membranes of the fetus in utero. XI. 1. *Inanimate cryſtals. Animated organization. Microſcopic animalcula from ſtagnation of vegetable and animal fluids. Do not generate.* 2. *Second kind of animal production commences in more points than one: not like microſcopic animals; as truffles, fungi, polypi, hydra.* 3. *Other vegetables are hermaphrodite, but both their ſexual glands ſecrete from the ſame maſs of blood.* 4. *Other vegetables have acquired ſeparate ſexes, and ſecrete the prolific fluids from different maſſes of blood. The embryon begins in more points in the more complicated animals. The primary parts fabricate ſecondary ones, as in the claſs dioecia of vegetables, and in ſexual animals. Nature is yet in her infancy.* 5. *Spontaneous production of microſcopic animalcules. Is ſimilar to actual generation. The firſt animacules generate others, and improve. Seedling tulip-root. Aphis. Immutable laws impreſſed on matter.* XII. *Concluſion. Of cauſe and effect. The atomic philoſophy leads to a firſt cauſe.*

I. The ingenious Dr. Hartley in his work on man, and ſome other philoſophers, have been of opinion, that our immortal part acquires during this life certain habits of action or of ſentiment, which become for ever indiſſoluble, continuing after death in a future ſtate of exiſtence; and add, that if theſe habits are of the malevolent kind, they muſt render the poſſeſſor miſerable even in Heaven. I would apply this ingenious idea to the generation or production of the embryon, or new animal, which partakes ſo much of the form and propenſities of the parent.

Owing to the imperfection of language the offspring is termed a *new* animal, but is in truth a branch or elongation of the parent; ſince a part of the embryon-animal is, or was, a part of the parent; and therefore in ſtrict language it cannot be ſaid to be entirely *new* at the time of its production; and therefore it may retain ſome of the habits of the parent-ſyſtem.

At the earlieſt period of its exiſtence the embryon, as ſecreted from the blood of the male, would ſeem to conſiſt of a living filament with certain capabilities of irritation, ſenſation, volition, and aſſociation; and alſo with ſome acquired habits or propenſities peculiar to the parent: the former of theſe are in common with other animals; the latter ſeem to diſtinguiſh or produce the kind of animal, whether man or quadruped, with the ſimilarity of feature or form to the parent. It is difficult to be conceived, that a living entity can be ſeparated or produced from the blood by the action of a gland; and which ſhall afterwards become an animal ſimilar to that in whoſe veſſels it is formed; even though we ſhould ſuppoſe with ſome modern theoriſts, that the blood is alive; yet every other hypotheſis concerning generation reſts on principles ſtill more difficult to our comprehenſion.

At the time of procreation this ſpeck of entity is received into an appropriated nidus, in which it muſt acquire two circumſtances neceſſary to its life and growth; one of theſe is food or ſuſtenance,

nance, which is to be received by the abſorbent mouths of its veſſels; and the other is that part of atmoſpherical air, or of water, which by the new chemiſtry is termed oxygene, and which affects the blood by paſſing through the coats of the veſſels which contain it. The fluid ſurrounding the embryon in its new habitation, which is called liquor amnii, ſupplies it with nouriſhment; and as ſome air cannot but be introduced into the uterus along with a new embryon, it would ſeem that this ſame fluid would for a ſhort time, ſuppoſe for a few hours, ſupply likewiſe a ſufficient quantity of the oxygene for its immediate exiſtence.

On this account the vegetable impregnation of aquatic plants is performed in the air; and it is probable that the honey-cup or nectary of vegetables requires to be open to the air, that the anthers and ſtigmas of the flower may have food of a more oxygenated kind than the common vegetable ſap-juice.

On the introduction of this primordium of entity into the uterus the irritation of the liquor amnii, which ſurrounds it, excites the abſorbent mouths of the new veſſels into action; they drink up a part of it, and a pleaſurable ſenſation accompanies this new action; at the ſame time the chemical affinity of the oxygene acts through the veſſels of the rubeſcent blood; and a previous

want,

It has been found that a bladder
filled with oxygen does not become
[illegible] from exposure to the air, of course
it follows that it cannot be [illegible]
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want, or diſagreeable ſenſation, is relieved by this proceſs.

As the want of this oxygenation of the blood is perpetual, (as appears from the inceſſant neceſſity of breathing by lungs or gills,) the veſſels become extended by the efforts of pain or deſire to ſeek this neceſſary object of oxygenation, and to remove the diſagreeable ſenſation, which that want occaſions. At the ſame time new particles of matter are abſorbed, or applied to theſe extended veſſels, and they become permanently elongated, as the fluid in contact with them ſoon loſes the oxygenous part, which it at firſt poſſeſſed, which was owing to the introduction of air along with the embryon. Theſe new blood-veſſels approach the ſides of the uterus, and penetrate with their fine terminations into the veſſels of the mother; or adhere to them, acquiring oxygene through their coats from the paſſing currents of the arterial blood of the mother. See Sect. XXXVIII. 2.

This attachment of the placental veſſels to the internal ſide of the uterus by their own proper efforts appears further illuſtrated by the many inſtances of extra-uterine fetuſes, which have thus attached or inſerted their veſſels into the peritoneum; or on the viſcera, exactly in the ſame manner as they naturally inſert or attach them to the uterus.

The abſorbent veſſels of the embryon continue to drink up nouriſhment from the fluid in which they ſwim, or liquor amnii; and which at firſt needs no previous digeſtive preparation; but which, when the whole apparatus of digeſtion becomes complete, is ſwallowed by the mouth into the ſtomach, and being mixed with ſaliva, gaſtric juice, bile, pancreatic juice, and mucus of the inteſtines, becomes digeſted, and leaves a recrement, which produces the firſt feces of the infant, called meconium.

The liquor amnii is ſecreted into the uterus, as the fetus requires it, and may probably be produced by the irritation of the fetus as an extraneous body; ſince a ſimilar fluid is acquired from the peritoneum in caſes of extra-uterine geſtation. The young caterpillars of the gadfly placed in the ſkins of cows, and the young of the ichneumon-fly placed in the backs of the caterpillars on cabbages, ſeem to produce their nouriſhment by their irritating the ſides of their nidus. A vegetable ſecretion and concretion are thus produced on oak-leaves by the gall-inſect, and by the cynips in the bedeguar of the roſe; and by the young graſshopper on many plants, by which the animal ſurrounds itſelf with froth. But in no circumſtance is extra-uterine geſtation ſo exactly reſembled as by the eggs of a fly, which are depoſited in the frontal ſinus of ſheep and calves. Theſe eggs float in ſome ounces of fluid collected in a thin pellicle or hydatid. This bag of fluid compreſſes the optic nerve on one ſide, by which the viſion being leſs diſtinct in that eye, the animal turns in perpetual circles towards the ſide affected, in order to get a more accurate view of objects; for the ſame reaſon as in ſquinting the affected eye is turned away from the object contemplated. Sheep in the warm months keep their noſes cloſe to the ground to prevent this fly from ſo readily getting into their noſtrils.

The liquor amnii is ſecreted into the womb as it is required, not only in reſpect to quantity, but, as the digeſtive powers of the fetus become formed, this fluid becomes of a different conſiſtence and quality, till it is exchanged for milk after nativity. Haller. Phyſiol. V. 1. In the egg the white part, which is analogous to the liquor amnii of quadrupeds, conſiſts of two diſtinct parts; one of which is more viſcid, and probably more difficult of digeſtion, and more nutritive than the other; and this latter is uſed in the laſt week of incubation. The yolk of the egg is a ſtill ſtronger or more nutritive fluid, which is drawn up into the bowels of the chick juſt at its excluſion from the ſhell, and ſerves it for nouriſhment for a day or two, till it is able to digeſt, and has learnt to chooſe the harder ſeeds or grains, which are to afford it ſuſtenance. Nothing analogous to this yolk is found in the fetus of lactiferous animals, as the milk is another nutritive fluid

ready

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ready prepared for the young progeny; it is alſo a curious circumſtance, that the firſt milk of female animals after parturition is much thicker, like the yolk of egg, and much more coagulable, than that which is ſecreted after a few days, when the digeſtive powers of the offspring are become ſtronger.

The yolk therefore is not neceſſary to the ſpawn of fiſh, the eggs of inſects, or for the ſeeds of vegetables; as their embryons have probably their food preſented to them as ſoon as they are excluded from their ſhells, or have extended their roots. Whence it happens that ſome inſects produce a living progeny in the ſpring and ſummer, and eggs in the autumn; and ſome vegetables have living roots or buds produced in the place of ſeeds, as the polygonum viviparum, and magical onions. See Botanic Garden, p. ii. art. Anthoxanthum.

There ſeems however to be a reſervoir of nutriment prepared for ſome ſeeds beſides their cotyledons or ſeed-leaves, which may be ſuppoſed in ſome meaſure analogous to the yolk of the egg. Such are the ſaccharine juices of apples, grapes, and other fruits, which ſupply nutrition to the ſeeds after they fall on the ground. And ſuch is the milky juice in the centre of the cocoa-nut, and part of the kernel of it; the ſame I ſuppoſe of all other monocotyledon ſeeds, as of the palms, graſſes, and lilies. The milky juice in the centre of the cocoa-nut ſeems curiouſly to reſemble the chyle of animals, as it contains oil diffuſed with mucilage and ſugar, whence ariſes its white colour; whereas the chyle or ſap-juice of vegetables, which exſudes from wounds of birch or maple-trees in the vernal months, is tranſparent, and conſiſts only of ſugar and mucilage, and in this circumſtance differs from the chyle of animals.

II. 1. The proceſs of generation is ſtill involved in impenetrable obſcurity, conjectures may nevertheleſs be formed concerning ſome of its circumſtances. Firſt, the eggs of fiſh and frogs are impregnated, after they leave the body of the female; becauſe they are depoſited in a fluid, and are not therefore covered with a hard ſhell. It is however remarkable, that neither frogs nor fiſh will part with their ſpawn without the preſence of the male; on which account female carp and gold-fiſh in ſmall ponds, where there are no males, frequently die from the diſtention of their growing ſpawn. 2. The eggs of fowls, which are laid without being impregnated, are ſeen to contain only the yolk and white, which are evidently the food or ſuſtenance for the future chick. 3. As the cicatricula of theſe eggs is given by the cock, and is evidently the rudiment of the new animal; we may conclude, that the embryon is produced by the male, and the proper food and nidus by the female. For if the female be ſuppoſed to form an equal part of the embryon, why ſhould ſhe form the whole of the apparatus for nutriment and for oxygenation? The male in many animals is larger, ſtronger, and digeſts more food than the female, and therefore ſhould contibute as much or more towards the reproduction of the ſpecies; but if he contributes only half the embryon and none of the apparatus for ſuſtenance and oxygenation, the diviſion is unequal; the ſtrength of the male, and his conſumption of food are too great for the effect, compared with that of the female, which is contrary to the uſual courſe of nature.

It has been ſuppoſed by ſome inquirers into the proceſs of generation, that the male ſemen in many animals could not come into contact with the ovum of the female; and they have hence ſuppoſed, that an aerial or ethereal emanation from the ſemen virile might ſerve the purpoſe of ſtimulating into life the ovum muliebre, becauſe in the vegetable ſtigma of ſome flowers no veſſels have been ſeen to receive and tranſmit the burſting anther-duſt; and becauſe it is not poſſible, that the ejaculatio feminis in quadrupeds could ſend it through the fallopian tubes to the veſicles of the ovaria.

In reſpect to the analogies from other animals, 1ſt, It may be obſerved, that in the generation of frogs, it is well known, that the male ſperm is effuſed in contact with the female ſpawn, as it leaves her body, and that in fiſh the male ſperm is likewiſe effuſed on the female ſpawn after its production. 2d. In reſpect to vegetables, it muſt be recollected, that their veſſels are ſo minute in diameter, that they have not in general been of ſufficient ſize to be injected by coloured fluids; and are not thence ſo viſible by microſcopes as thoſe of animals, and that it is probable, thoſe of the ſtigma or piſtillum of flowers, which are deſigned to abſorb the ſolution of the anther-duſt, which adheres to the moiſt ſtigma, may be always empty, or have their mouths cloſed, except when they are ſtimulated into action by the anther-duſt, and may thence more eaſily eſcape obſervation. Nor do I know, that any one has endeavoured to detect theſe veſſels by experiments with coloured liquids applied along with the male farina on the ſtigma for its abſorption, or by diſſecting the piſtillum as in its recent or dry ſtate, or by obſerving it in a ſtate of charcoal.

In regard to quadrupeds, Dr. Haighton has ſhewn by a number of curious experiments on rabbits, publiſhed in the Philoſoph. Tranſact. for the year 1797, that the male ſemen does not permeate the fallopian tubes, and conſequently never arrives at the female ova, either in a liquid or aerial ſtate; but that it is by the ſtimulus of the ſemen in the neck of the uterus; that the veſicles of the ovaria ſwell, and diſcharge the material, which has been called an ovum, though it does not poſſeſs a diſtinguiſhable form; and that this is acquired and carried into the uterus by the periſtaltic motions of the fallopian tubes, ſome hours after copulation. Here I ſuppoſe it finds the male ſemen, and that thus the new animal produced by the ſecretion of the male finds correſponding nutriment and ſituation in the female in all ſexual progeny. But that no female apparatus is required in the production of the buds of trees, or in the adherent fetus of the polypus, or of the coral-inſects.

In objection to this theory of generation it may be ſaid, if the animalcula in ſemine, as ſeen by the microſcope, be all of them rudiments of homunculi, when but one of them can find a nidus, what a waſte nature has made of her productions? I do not aſſert that theſe moving particles, viſible by the microſcope, are homunciones; perhaps they may be the creatures of ſtagnation or putridity, or perhaps no creatures at all; but if they are ſuppoſed to be rudiments of homunculi, or embryons, ſuch a profuſion of them correſponds with the general efforts of nature to provide for the continuance of her ſpecies of animals. Every individual tree produces innumerable ſeeds, and every individual fiſh innumerable ſpawn, in ſuch inconceivable abundance as would in a ſhort ſpace of time crowd the earth and ocean with inhabitants; and theſe are much more perfect animals than the animalcula in ſemine can be ſuppoſed to be, and periſh in uncounted millions. This argument only ſhews, that the productions of nature are governed by general laws; and that by a wiſe ſuperfluity of proviſion ſhe has enſured their continuance.

2. That the embryon is ſecreted or produced by the male, and not by the conjunction of fluids from both male and female, appears from the analogy of vegetable ſeeds. In the large flowers, as the tulip, there is no ſimilarity of apparatus between the anthers and the ſtigma: the ſeed is produced according to the obſervations of Spallanzani long before the flowers open, and in conſequence long before it can be impregnated, like the egg in the pullet. And after the prolific duſt is ſhed on the ſtigma, the ſeed becomes coagulated in one point firſt, like the cicatricula of the impregnated egg. See Botanic Garden, Part I. additional note 38. Now in theſe ſimple products of nature, if the female contributed to produce the new embryon equally with the male, there would probably have been ſome viſible ſimilarity of parts for this purpoſe, beſides thoſe neceſſary for the nidus and ſuſtenance of the new progeny. Beſides in many flowers the males are more numerous than the females, or than the ſeparate uterine cells in their germs, which would ſhew, that the office of the male was at leaſt as important as that of the female; whereas if the male, beſides producing the egg or ſeed, was to produce an equal part of the embryon,

the office of reproduction would be unequally divided between them.

Add to this, that in the moſt ſimple kind of vegetable reproduction, I mean the buds of trees, which are the viviparous offspring, the leaf is evidently the parent of the bud, which riſes in its boſom, according to the obſervation of Linnæus. This leaf conſiſts of abſorbent veſſels, and pulmonary ones, to obtain its nutriment, and to impregnate it with oxygene. This ſimple piece of living organization is alſo furniſhed with a power of reproduction; and as the new offspring is thus ſupported adhering to its father, it needs no mother to ſupply it with a nidus, and nutriment, and oxygenation; and hence no female leaf has exiſtence.

I did conceive that the veſſels between the bud and the leaf communicated or inoſculated; and that the bud was thus ſerved with vegetable blood, that is, with both nutriment and oxygenation, till the death of the parent-leaf in autumn. And that in this reſpect it differed from the fetus of viviparous animals. But, ſince the former editions of this work were publiſhed, I have been induced to change that opinion; as on diſſecting the bud of the horſe-cheſnut, æſculus hippocaſtanum, as mentioned below, no communication of veſſels between the leaf and the bud generated in its boſom could be perceived, ſo that it is more probably nouriſhed by abſorbing the fluid, with which it is ſurrounded, like the fetus of animals, as ſhewn in my work on vegetation, termed Phytologia. Sect. VII. 1. 2. Secondly, I conceive that then the bark-veſſels belonging to the dead leaf, and in which I ſuppoſe a kind of manna to have been depoſited, become now the placental veſſels, if they may be ſo called, of the new bud. From the vernal ſap thus produced of one ſugar-maple-tree in New-York and in Pennſylvania, five or ſix pounds of good ſugar may be made annually without deſtroying the tree. Account of maple-ſugar by B. Ruſh. London, Phillips. (See Botanic Garden, Part I. additional note on vegetable placentation.)

Theſe veſſels, when the warmth of the vernal ſun hatches the young bud, ſerve it with a ſaccharine nutriment, till it acquires leaves of its own, and ſhoots a new ſyſtem of abſorbents down the bark and root of the tree, juſt as the farinaceous or oily matter in ſeeds, and the ſaccharine matter in fruits, ſerve their embryons with nutriment, till they acquire leaves and roots. This analogy is as forceable in ſo obſcure a ſubject, as it is curious, and may in large buds, as of the horſe-cheſnut, be almoſt ſeen by the naked eye; if with a penknife the remaining rudiment of the laſt year's leaf, and of the new bud in its boſom, be cut away ſlice by ſlice. The ſeven ribs of the laſt year's leaf will be ſeen to have ariſen from the pith in ſeven diſtinct points making a curve;

and the new bud to have been produced in their centre, and to have pierced the alburnum and cortex, and grown without the aſſiſtance of a mother. A ſimilar proceſs may be ſeen on diſſecting a tulip-root in winter; the leaves, which encloſed the laſt year's flower-ſtalk, were not neceſſary for the flower; but each of theſe was the father of a new bud, which may be now found at its baſe; and which, as it adheres to the parent, required no mother.

This paternal offspring of vegetables, I mean their buds and bulbs, is attended with a very curious circumſtance; and that is, that they exactly reſemble their parents, as is obſervable in grafting fruit-trees, and in propagating flower-roots; whereas the ſeminal offspring of plants, being ſupplied with nutriment by the mother, is liable to perpetual variation. Thus alſo in the vegetable claſs dioecia, where the male flowers are produced on one tree, and the female ones on another; the buds of the male trees uniformly produce either male flowers, or other buds ſimilar to themſelves; and the buds of the female trees produce either female flowers, or other buds ſimilar to themſelves; whereas the ſeeds of theſe trees produce either male or female plants. From this analogy of the production of vegetable buds without a mother, I contend that the mother does not contribute to the formation of the living ens in animal generation, but is neceſſary only for ſupplying its nutriment and oxygenation.

There is another vegetable fact publiſhed by M. Koelreuter, which he calls "a complete metamorphoſis of one natural ſpecies of plants into another," which ſhews, that in ſeeds as well as in buds, the embryon proceeds from the male parent, though the form of the ſubſequent mature plant is in part dependant on the female. M. Koelreuter impregnated a ſtigma of the nicotiana ruſtica with the farina of the nicotiana paniculata, and obtained prolific ſeeds from it. With the plants which ſprung from theſe ſeeds, he repeated the experiment, impregnating them with the farina of the nicotiana paniculata. As the mule plants which he thus produced were prolific, he continued to impregnate them for many generations with the farina of the nicotiana paniculata, and they became more and more like the male parent, till he at length obtained ſix plants in every reſpect perfectly ſimilar to the nicotiana paniculata; and in no reſpect reſembling their female parent the nicotiana ruſtica, *Blumenbach* on Generation.

3. It is probable that the inſects, which are ſaid to require but one impregnation for ſix generations, as the aphis (ſee Amenit. Academ.) produce their progeny in the manner above deſcribed, that is, without a mother, and not without

out a father; and thus experience a lucina ſine concubitu. Thoſe who have attended to the habits of the polypus, which is found in the ſtagnant water of our ditches in July, affirm, that the young ones branch out from the ſide of the parent like the buds of trees, and after a time ſeparate themſelves from them. This is ſo analogous to the manner in which the buds of trees appear to be produced, that theſe polypi may be conſidered as all male animals, producing embryons, which require no mother to ſupply them with a nidus, or with nutriment, and oxygenation.

This lateral or lineal generation of plants, not only obtains in the buds of trees, which continue to adhere to them, but is beautifully ſeen in the wires of knot-graſs, polygonum aviculare, and in thoſe of ſtrawberries, fragaria veſca. In theſe an elongated creeping bud is protruded, and, where it touches the ground, takes root, and produces a new plant derived from its father, from which it acquires both nutriment and oxygenation; and in conſequence needs no maternal apparatus for theſe purpoſes. In viviparous flowers, as thoſe of allium magicum, and polygonum viviparum, the anthers and the ſtigmas become effete and periſh; and the lateral or paternal offspring ſucceed inſtead of ſeeds, which adhere till they are ſufficiently mature, and then fall upon the ground, and take root like other bulbs.

The lateral production of plants by wires, while each new plant is thus chained to its parent, and continues to put forth another and another, as the wire creeps onward on the ground, is exactly reſembled by the tape-worm, or tænia, ſo often found in the bowels, ſtretching itſelf in a chain quite from the ſtomach to the rectum. Linnæus aſſerts, "that it grows old at one extremity, while it continues to generate young ones at the other, proceeding ad infinitum, like a root of graſs. The ſeparate joints are called gourd-worms, and propagate new joints like the parent without end, each joint being furniſhed with its proper mouth, and organs of digeſtion." Syſtema naturæ. Vermes tenia. In this animal there evidently appears a power of reproduction without any maternal apparatus for the purpoſe of ſupplying nutriment and oxygenation to the embryon, as it remains attached to its father till its maturity. The volvox globator, which is a tranſparent animal, is ſaid by Linnæus to bear within it ſons and grand-ſons to the fifth generation. Theſe are probably living fetuſes, produced by the father, of different degrees of maturity, to be detruded at different periods of time, like the unimpregnated eggs of various ſizes, which are found in poultry; and as they are produced without any known copulation, contribute to evince, that the living embryon in other orders of animals is formed by the male parent, and not by the mother, as one parent has the power to produce it.

This idea of the reproduction of animals from a ſingle living filament of their fathers, appears to have been ſhadowed or allegorized in the curious account in ſacred writ of the formation of Eve from a rib of Adam.

From all theſe analogies I conclude, that the embryon is produced ſolely by the male, and that the female ſupplies it with a proper nidus, with ſuſtenance, and with oxygenation; and that the idea of the ſemen of the male conſtituting only a ſtimulus to the egg of the female, exciting it into life, (as held by ſome philoſophers) has no ſupport from experiment or analogy.

III. 1. Many ingenious philoſophers have found ſo great difficulty in conceiving the manner of the reproduction of animals, that they have ſuppoſed all the numerous progeny to have exiſted in miniature in the animal originally created; and that theſe infinitely minute forms are only evolved or diſtended, as the embryon increaſes in the womb. This idea, beſides its being unſupported by any analogy we are acquainted with, aſcribes a greater tenuity to organized matter, than we can readily admit; as theſe included embryons are ſuppoſed each of them to conſiſt of the various and complicate parts of animal bodies: they muſt poſſeſs a much greater degree of minuteneſs, than that which was aſcribed to the devils that tempted St. Anthony; of whom 20,000 were ſaid to have been able to dance a ſaraband on the point of the fineſt needle without incommoding each other.

2. Others have ſuppoſed, that all the parts of the embryon are formed in the male, previous to its being depoſited in the egg or uterus; and that it is then only to have its parts evolved or diſtended as mentioned above; but this is only to get rid of one difficulty by propoſing another equally incomprehenſible: they found it difficult to conceive, how the embryon could be formed in the uterus or egg, and therefore wiſhed it to be formed before it came thither. In anſwer to both theſe doctrines it may be obſerved, 1ſt, that ſome animals, as the crab-fiſh, can reproduce a whole limb, as a leg which has been broken off; others, as worms and ſnails, can reproduce a head, or a tail, when either of them has been cut away; and that hence in theſe animals at leaſt a part can be formed anew, which cannot be ſuppoſed to have exiſted previouſly in miniature.

Secondly, there are new parts or new veſſels produced in many diſeaſes, as on the cornea of the eye in ophthalmy, in wens and cancers, which cannot be ſuppoſed to have had a prototype or original miniature in the embryon.

Thirdly, how could mule-animals be produced, which partake of the forms of both the parents, if the original embryon was a miniature exiſting in the ſemen of the male parent? if an embryon of the male aſs was only expanded, no reſemblance to the mare could exiſt in the mule.

This miſtaken idea of the extenſion of parts ſeems to have had its riſe from the mature man reſembling the general form of the fetus; and from thence it was believed, that the parts of the fetus were diſtended into the man; whereas they have increaſed 100 times in weight, as well as 100 times in ſize; now no one will call the additional ninety-nine parts a diſtention of the original one part in reſpect to weight. Thus the uterus during pregnancy is greatly enlarged in thickneſs and ſolidity as well as in capacity, and hence muſt have acquired this additional ſize by accretion of new parts, not by an extenſion of the old ones; the familiar act of blowing up the bladder of an animal recently ſlaughtered has led our imaginations to apply this idea of diſtention to the increaſe of ſize from natural growth; which however muſt be owing to the appoſition of new parts; as it is evinced from the increaſe of weight along with the increaſe of dimenſion; and is even viſible to our eyes in the elongation of our hair from the colour of its ends; or when it has been dyed on the head; and in the growth of our nails from the ſpecks ſometimes obſervable on them; and in the increaſe of the white creſcent at their roots, and in the growth of new fleſh in wounds, which conſiſts of new nerves as well as of new blood-veſſels.

3. Laſtly, Mr. Buffon has with great ingenuity imagined the exiſtence of certain organic particles, which are ſuppoſed to be partly alive, and partly mechanic ſprings. The latter of theſe were diſcovered by Mr. Needham in the milt or male organ of a ſpecies of cuttle fiſh, called calmar; the former, or living animalcula, are found in both male and female ſecretions, in the infuſions of ſeeds, as of pepper, in the jelly of roaſted veal, and in all other animal and vegetable ſubſtances. Theſe organic particles he ſuppoſes to exiſt in the ſpermatic fluids of both ſexes, and that they are derived thither from every part of the body, and muſt therefore reſemble, as he ſuppoſes, the parts from whence they are derived. Theſe organic particles he believes to be in conſtant activity, till they become mixed in the womb, and then they inſtantly join and produce an embryon or fetus ſimilar to the two parents.

Many objections might be adduced to this ingenious theory; I ſhall only mention two. Firſt, that it is analogous to no known animal laws. And ſecondly, that as theſe fluids, replete with organic particles derived both from the male and female organs, are ſuppoſed to be ſimilar; there is no reaſon why the mother ſhould not produce a female embryon without the aſſiſtance of the male, and realize the lucina ſine concubitu. See No. 8 and 9 of this ſection, and Sect. XXXVII. 3.

IV. 1. I conceive the primordium, or rudiment of the embryon, as ſecreted from the blood of the parent, to conſiſt of a ſimple living filament as a muſcular fibre; which I ſuppoſe to be an extremity of a nerve of loco-motion, as a fibre of the retina is an extremity of a nerve of ſenſation; as for inſtance one of the fibrils, which compoſe the mouth of an abſorbent veſſel; I ſuppoſe this living filament, of whatever form it may be, whether ſphere, cube, or cylinder, to be endued with the capability of being excited into action by certain kinds of ſtimulus. By the ſtimulus of the ſurrounding fluid, in which it is received from the male, it may bend into a ring: and thus form the beginning of a tube. Such moving filaments, and ſuch rings, are deſcribed by thoſe, who have attended to microſcopic animalcula. This living ring may now embrace or abſorb a nutritive particle of the fluid, in which it ſwims; and by drawing it into its pores, or joining it by compreſſion to its extremities, may increaſe its own length or craſſitude; and by degrees the living ring may become a living tube.

2. With this new organization, or accretion of parts, new kinds of irritability may commence; for ſo long as there was but one living organ, it could only be ſuppoſed to poſſeſs irritability; ſince ſenſibility may be conceived to be an extenſion

tenſion of the effect of irritability over the reſt of the ſyſtem. Theſe new kinds of irritability and of ſenſibility in conſequence of new organization, appear from variety of facts in the more mature animal; thus the formation of the teſtes, and conſequent ſecretion of the ſemen, occaſion the paſſion of luſt; the lungs muſt be previouſly formed before their exertions to obtain freſh air can exiſt; the throat or œſophagus muſt be formed previous to the ſenſation or appetites of hunger and thirſt; one of which ſeems to reſide at the upper end, and the other at the lower end of that canal.

Thus alſo the glans penis, when it is diſtended with blood, acquires a new ſenſibility, and a new appetency. The ſame occurs to the nipples of the breaſts of female animals; when they are diſtended with blood, they acquire the new appetency of giving milk. So inflamed tendons and membranes, and even bones, acquire new ſenſations; and the parts of mutilated animals, as of wounded ſnails, and polypi, and crabs, are reproduced; and at the ſame time acquire ſenſations adapted to their ſituations. Thus when the head of a ſnail is reproduced after decollation with a ſharp raſor, thoſe curious teleſcopic eyes are alſo reproduced, and acquire their ſenſibility to light, as well as their adapted muſcles for retraction on the approach of injury.

With every new change, therefore, of organic form, or addition of organic parts, I ſuppoſe a new kind of irritability or of ſenſibility to be produced; ſuch varieties of irritability or of ſenſibility exiſt in our adult ſtate in the glands; every one of which is furniſhed with an irritability, or a taſte, or appetency, and a conſequent mode of action peculiar to itſelf.

In this manner I conceive the veſſels of the jaws to produce the teeth, thoſe of the fingers to produce the nails, thoſe of the ſkin to produce the hair; in the ſame manner as afterwards about the age of puberty the beard and other great changes in the form of the body, and diſpoſition of the mind, are produced in conſequence of the new ſecretion of ſemen; for if the animal is deprived of this ſecretion thoſe changes do not take place. Theſe changes I conceive to be formed not by elongation or diſtention of primeval ſtamina, but by appoſition of parts; as the mature crab-fiſh, when deprived of a limb, in a certain ſpace of time has power to regenerate it; and the tadpole puts forth its feet long after its excluſion from the ſpawn; and the caterpillar in changing into a butterfly acquires a new form, with new powers, new ſenſations, and new deſires.

The natural hiſtory of butterflies, and moths, and beetles, and gnats, is full of curioſity; ſome of them paſs many months, and others even years, in their caterpillar or grub ſtate; they then reſt many weeks without food, ſuſpended in the air, buried in the earth, or ſubmerſed in water: and change themſelves during this time into an animal apparently of a different nature; the ſtomachs of ſome of them, which before digeſted vegetable leaves or roots, now only digeſt honey; they have acquired wings for the purpoſe of ſeeking this new food, and a long proboſcis to collect it from flowers, and I ſuppoſe a ſenſe of ſmell to detect the ſecret places in flowers, where it is formed. The moths, which fly by night, have a much longer proboſcis rolled up under their chins like a watch ſpring; which they extend to collect the honey from flowers in their ſleeping ſtate; when they are cloſed, and the nectaries in conſequence more difficult to be plundered. The beetle kind are furniſhed with an external covering of a hard material to their wings, that they may occaſionally again make holes in the earth, in which they paſſed the former ſtate of their exiſtence.

But what moſt of all diſtinguiſhes theſe new animals is, that they are now furniſhed with the powers of reproduction; and that they now differ from each other in ſex, which does not appear in their caterpillar or grub ſtate. In ſome of them the change from a caterpillar into a butterfly or moth ſeems to be accompliſhed for the ſole purpoſe of their propagation; ſince they immediately die after this is finiſhed, and take no food in the interim, as the ſilk-worm in this climate; though it is poſſible it might take honey as food, if it was preſented to it. For in general it would ſeem, that food of a more ſtimulating kind, the honey of vegetables inſtead of their leaves, was neceſſary for the purpoſe of the ſeminal reproduction of theſe animals, exactly ſimilar to what happens in vegetables; in theſe the juices of the earth are ſufficient for their purpoſe of reproduction by buds or bulbs; in which the new plant ſeems to be formed by irritative motions, like the growth of their other parts, as their leaves or roots; but for the purpoſe of ſeminal or amatorial reproduction, where ſenſation is required, a more ſtimulating food becomes neceſſary for the anther and ſtigma; and this food is honey; as explained in Sect. XIII. on Vegetable Animation.

The gnat and the tadpole reſemble each other in their change from natant animals with gills into aerial animals with lungs; and in their change of the element in which they live; and probably of the food, with which they are ſupported; and laſtly, with their acquiring in their new ſtate the difference of ſex, and the organs of ſeminal or amatorial reproduction. While the polypus, who is their companion in their former ſtate of life, not being allowed to change his form and element, can only propagate like vegetable buds by the ſame kind of irritative motions, which

which produces the growth of his own body, without the ſeminal or amatorial propagation, which requires ſenſation; and which in gnats and tadpoles ſeems to require a change both of food and of reſpiration.

From hence I conclude, that with the acquiſition of new parts, new ſenſations, and new deſires, as well as new powers, are produced; and this by accretion to the old ones, and not by diſtention of them. And finally, that the moſt eſſential parts of the ſyſtem, as the brain for the purpoſe of diſtributing the power of life, and the placenta for the purpoſe of oxygenating the blood, and the additional abſorbent veſſels for the purpoſe of acquiring aliment, are firſt formed by the irritations above mentioned, and by the pleaſurable ſenſations attending thoſe irritations, and by the exertions in conſequence of painful ſenſations, ſimilar to thoſe of hunger and ſuffocation. After theſe an apparatus of limbs for future uſes, or for the purpoſe of moving the body in its preſent natant ſtate, and of lungs for future reſpiration, and of teſtes for future reproduction, are formed by the irritations and ſenſations, and conſequent exertions of the parts previouſly exiſting, and to which the new parts are to be attached.

3. In confirmation of theſe ideas it may be obſerved, that all the parts of the body endeavour to grow, or to make additional parts to themſelves

throughout our lives; but are reſtrained by the parts immediately containing them; thus, if the ſkin be taken away, the fleſhy parts beneath ſoon ſhoot out new granulations, called by the vulgar proud fleſh. If the perioſteum be removed, a ſimilar growth commences from the bone. Now in the caſe of the imperfect embryon, the containing or confining parts are not yet ſuppoſed to be formed, and hence there is nothing to reſtrain its growth.

4. By the parts of the embryon being thus produced by new appoſitions, many phenomena both of animal and vegetable productions receive an eaſier explanation; ſuch as that many fetuſes are deficient at the extremities, as in a finger or a toe, or in the end of the tongue, or in what is called a hare-lip with deficiency of the palate. For if there ſhould be a deficiency in the quantity of the firſt nutritive particles laid up in the egg for the reception of the firſt living filament, the extreme parts, as being laſt formed, muſt ſhew this deficiency by their being imperfect.

This idea of the growth of the embryon accords alſo with the production of ſome monſtrous births, which conſiſt of a duplicature of the limbs, as chickens with four legs; which could not occur, if the fetus was formed by the diſtention of an original ſtamen, or miniature. For if there ſhould be a ſuperfluity of the firſt nutritive particles laid up in the egg for the firſt living filament; it is eaſy to conceive, that a duplicature of ſome parts may be formed. And that ſuch ſuperfluous nouriſhment ſometimes exiſts, is evinced by the double yolks in ſome eggs, which I ſuppoſe were thus formed previous to their impregnation by the exuberant nutriment of the hen.

This idea is confirmed by the analogy of the monſters in the vegetable world alſo; in which a duplicate or triplicate production of various parts of the flower is obſervable, as a triple nectary in ſome columbines, and a triple petal in ſome primroſes; and which are ſuppoſed to be produced by abundant nouriſhment.

5. If the embryon be received into a fluid, the ſtimulus of which is different in ſome degree from the natural, as in the production of mule-animals, the new irritabilities or ſenſibilities acquired by the increaſing or growing organized parts may differ, and thence produce parts not ſimilar to the father, but of a kind belonging in part to the mother; and thus, though the original ſtamen or living ens was derived totally from the father, yet new irritabilities or ſenſibilities being excited, a change of form correſponding with them will be produced. Nor could the production of mules exiſt, if the ſtamen or miniature of all the parts of the embryon is previouſly formed in the male ſemen, and is only diſtended by nouriſhment in the female uterus. Whereas this difficulty ceaſes, if the embryon be ſuppoſed to con-

ſiſt of a living filament, which acquires or makes new parts with new irritabilities, as it advances its growth.

The form, ſolidity, and colour, of the particles of nutriment laid up for the reception of the firſt living filament, as well as their peculiar kind of ſtimulus, may contribute to produce a difference in the form, ſolidity, and colour of the fetus, ſo as to reſemble the mother, as it advances in life. This alſo may eſpecially happen during the firſt ſtate of the exiſtence of the embryon, before it has acquired organs, which can change theſe firſt nutritive particles, as explained in No. 5. 2. of this Section. And as theſe nutritive particles are ſuppoſed to be ſimilar to thoſe, which are formed for her own nutrition, it follows that the fetus ſhould ſo far reſemble the mother.

This explains, why hereditary diſeaſes may be derived either from the male or female parent, as well as the peculiar form of either of their bodies. Some of theſe hereditary diſeaſes are ſimply owing to a deficient activity of a part of the ſyſtem, as of the abſorbent veſſels, which open into the cells or cavities of the body, and thus occaſion dropſies. Others are at the ſame time owing to an increaſe of ſenſation, as in ſcrofula and conſumption; in theſe the obſtruction of the fluids is firſt cauſed by the inirritability of the veſſels, and the inflammation and ulcers which ſucceed, are cauſed by the conſequent increaſe of ſenſation in the obſtructed part. Other hereditary diſeaſes, as the epilepſy, and other convulſions, conſiſt in too great voluntary exertions in conſequence of diſagreeable ſenſation in ſome particular diſeaſed part. Now as the pains, which occaſion theſe convulſions, are owing to defect of the action of the diſeaſed part, as ſhewn in Sect. XXXIV. it is plain, that all theſe hereditary diſeaſes may have their origin either from defective irritability derived from the father, or from deficiency of the ſtimulus of the nutriment derived from the mother. In either caſe the effect would be ſimilar; as a ſcrofulous race is frequently produced among the poor from the deficient ſtimulus of bad diet, or of hunger; and among the rich, by a deficient irritability from their having been long accuſtomed to too great ſtimulus, as of vinous ſpirit.

6. From this account of reproduction it appears, that all animals have a ſimilar origin, viz. from a ſingle living filament; and that the difference of their forms and qualities has ariſen only from the different irritabilities and ſenſibilities, or voluntarities, or aſſociabilities, of this original living filament; and perhaps in ſome degree from the different forms of the particles of the fluids, by which it has been at firſt ſtimulated into activity. And that from hence, as Linnæus has conjectured in reſpect to the vegetable world,

it is not impoſſible, but the great variety of ſpecies of animals, which now tenant the earth, may have had their origin from the mixture of a few natural orders. And that thoſe animal and vegetable mules, which could continue their ſpecies, have done ſo, and conſtitute the numerous families of animals and vegetables which now exiſt; and that thoſe mules, which were produced with imperfect organs of generation, periſhed without reproduction, according to the obſervation of Ariſtotle; and are the animals, which we now call mules. See Botanic Garden, Part II. Note on Dianthus.

Such a promiſcuous intercourſe of animals is ſaid to exiſt at this day in New South Wales by Captain Hunter. And that not only amongſt the quadrupeds and birds of different kinds, but even amongſt the fiſh; and, as he believes, amongſt the vegetables. He ſpeaks of an animal between the opoſſum and the kangaroo, from the ſize of a ſheep to that of a rat. Many fiſh ſeemed to partake of the ſhark; ſome with a ſkait's head and ſhoulders, and the hind part of a ſhark; others with a ſhark's head and the body of a mullet; and ſome with a ſhark's head and the flat body of a ſting-ray. Many birds partake of the parrot; ſome have the head, neck, and bill of a parrot, with long ſtraight feet and legs; others with legs and feet of a parrot, with head and neck of a ſea-a ſea-gull. Voyage to South Wales by Captain John Hunter, p. 68.

7. All animals therefore, I contend, have a ſimilar cauſe of their organization, originating from a ſingle living filament, endued indeed with different kinds of irritabilities and ſenſibilities, or of animal appetencies; which exiſt in every gland, and in every moving organ of the body, and are as eſſential to living organization as chemical affinities are to certain combinations of inanimate matter.

If I might be indulged to make a ſimile in a philoſophical work, I ſhould ſay, that the animal appetencies, are not only perhaps leſs numerous originally than the chemical affinities; but that like theſe latter, they change with every new combination; thus vital air and azote, when combined, produce nitrous acid; which now acquires the property of diſſolving ſilver; ſo with every new additional part to the embryon, as of the throat or lungs, I ſuppoſe a new animal appetency to be produced.

In this early formation of the embryon from the irritabilities, ſenſibilities, and aſſociabilities, and conſequent appetencies, the faculty of volition can ſcarcely be ſuppoſed to have had its birth. For about what can the fetus deliberate when it has no choice of objects? But in the more advanced ſtate of the fetus, it evidently poſſeſſes volition; as it frequently changes its attitude,

tude, though it ſeems to ſleep the greateſt part of its time; and afterwards the power of volition contributes to change or alter many parts of the body during its growth to manhood, by our early modes of exertion in the various departments of life. All theſe faculties then conſtitute the vis fabricatrix, and the vis conſervatrix, as well as the vis medicatrix of nature, ſo much ſpoken of, but ſo little underſtood by philoſophers.

8. When we revolve in our minds, firſt, the great changes, which we ſee naturally produced in animals after their nativity, as in the production of the butterfly with painted wings from the crawling caterpillar; or of the reſpiring frog from the ſubnatant tadpole; from the feminine boy to the bearded man, and from the infant girl to the lacteſcent woman; both which changes may be prevented by certain mutilations of the glands neceſſary to reproduction.

Secondly, when we think over the great changes introduced into various animals by artificial or accidental cultivation, as in horſes, which we have exerciſed for the different purpoſes of ſtrength or ſwiftneſs, in carrying burthens or in running races; or in dogs, which have been cultivated for ſtrength and courage, as the bull-dog; or for acuteneſs of his ſenſe of ſmell, as the hound and ſpaniel; or for the ſwiftneſs of his foot, as the greyhound; or for his ſwimming in the water, or for drawing ſnow-ſledges, as the rough-haired dogs of the north; or laſtly, as a play-dog for children, as the lap-dog; with the changes of the forms of the cattle, which have been domeſticated from the greateſt antiquity, as camels, and ſheep; which have undergone ſo total a transformation, that we are now ignorant from what ſpecies of wild animals they had their origin. Add to theſe the great changes of ſhape and colour, which we daily ſee produced in ſmaller animals from our domeſtication of them, as rabbits, or pigeons; or from the difference of climates and even of ſeaſons; thus the ſheep of warm climates are covered with hair inſtead of wool; and the hares and partridges of the latitudes, which are long buried in ſnow, become white during the winter months; add to theſe the various changes produced in the forms of mankind, by their early modes of exertion; or by the diſeaſes occaſioned by their habits of life; both of which became hereditary, and that through many generations. Thoſe who labour at the anvil, the oar, or the loom, as well as thoſe who carry ſedan-chairs, or who have been educated to dance upon the rope, are diſtinguiſhable by the ſhape of their limbs; and the diſeaſes occaſioned by intoxication deform the countenance with leprous eruptions, or the body with tumid viſcera, or the joints with knots and diſtortions.

Thirdly, when we enumerate the great changes produced in the ſpecies of animals before their nativity; theſe are ſuch as reſemble the form or colour of their parents, which have been altered by the cultivation or accidents above related, and are thus continued to their poſterity. Or they are changes produced by the mixture of ſpecies as in mules; or changes produced probably by the exuberance of nouriſhment ſupplied to the fetus, as in monſtrous births with additional limbs; many of theſe enormities of ſhape are propagated, and continued as a variety at leaſt, if not as a new ſpecies of animal. I have ſeen a breed of cats with an additional claw on every foot; of poultry alſo with an additional claw, and with wings to their feet; and of others without rumps. Mr. Buffon mentions a breed of dogs without tails, which are common at Rome and at Naples, which he ſuppoſes to have been produced by a cuſtom long eſtabliſhed of cutting their tails cloſe off. There are many kinds of pigeons, admired for their peculiarities, which are monſters thus produced and propagated. And to theſe muſt be added, the changes produced by the imagination of the male parent, as will be treated of more at large in No. VI. of this Section.

When we conſider all theſe changes of animal form, and innumerable others, which may be collected from the books of natural hiſtory; we cannot but be convinced, that the fetus or embryon is formed by appoſition of new parts, and not by the diſtention of a primordial neſt of germes, included one within another, like the cups of a conjurer.

Fourthly, when we revolve in our minds the great ſimilarity of ſtructure which obtains in all the warm blooded animals, as well quadrupeds, birds, and amphibious animals, as in mankind; from the mouſe and bat to the elephant and whale; one is led to conclude, that they have alike been produced from a ſimilar living filament. In ſome this filament in its advance to maturity has acquired hands and fingers, with a fine ſenſe of touch, as in mankind. In others it has acquired claws or talons, as in tygers and eagles. In others, toes with an intervening web, or membrane, as in ſeals and geeſe. In others it has acquired cloven hoofs, as in cows and ſwine; and whole hoofs in others, as in the horſe. While in the bird kind this original living filament has put forth wings inſtead of arms or legs, and feathers inſtead of hair. In ſome it has protruded horns on the forehead inſtead of teeth in the fore part of the upper jaw; in others tuſhes inſtead of horns; and in others beaks inſtead of either. And all this exactly as is daily ſeen in the tranſmutations of the tadpole, which acquires legs and lungs, when he wants them; and loſes his tail, when it is no longer of ſervice to him.

Fifthly, from their firſt rudiment, or primordium, to the termination of their lives, all animals undergo perpetual transformations; which aro are in part produced by their own exertions in conſequence of their deſires and averſions, of their pleaſures and their pains, or of irritations, or of aſſociations; and many of theſe acquired forms or propenſities are tranſmitted to their poſterity. See Sect. XXXI. 1.

As air and water are ſupplied to animals in ſufficient profuſion, the three great objects of deſire, which have changed the forms of many animals by their exertions to gratify them, are thoſe of luſt, hunger, and ſecurity. A great want of one part of the animal world has conſiſted in the deſire of the excluſive poſſeſſion of the females; and theſe have acquired weapons to combat each other for this purpoſe, as the very thick, ſhield-like, horny ſkin on the ſhoulder of the boar is a defence only againſt animals of his own ſpecies, who ſtrike obliquely upwards, nor are his tuſhes for other purpoſes, except to defend himſelf, as he is not naturally a carnivorous animal. So the horns of the ſtag are ſharp to offend his adverſary, but are branched for the purpoſe of parrying or receiving the thruſts of horns ſimilar to his own, and have therefore been formed for the purpoſe of combating other ſtags for the excluſive poſſeſſion of the females; who are obſerved, like the ladies in the times of chivalry, to attend the car of the victor.

The birds, which do not carry food to their young, and do not therefore marry, are armed with ſpurs for the purpoſe of fighting for the excluſive poſſeſſion of the females, as cocks and quails. It is certain that theſe weapons are not provided for their defence againſt other adverſaries, becauſe the females of theſe ſpecies are without this armour. The final cauſe of this conteſt amongſt the males ſeems to be, that the ſtrongeſt and moſt active animal ſhould propagate the ſpecies, which ſhould thence become improved.

Another great want conſiſts in the means of procuring food, which has diverſified the forms of all ſpecies of animals. Thus the noſe of the ſwine has become hard for the purpoſe of turning up the ſoil in ſearch of inſects and of roots. The trunk of the elephant is an elongation of the noſe for the purpoſe of pulling down the branches of trees for his food, and for taking up water without bending his knees. Beaſts of prey have acquired ſtrong jaws or talons. Cattle have acquired a rough tongue and a rough palate to pull off the blades of graſs, as cows and ſheep. Some birds have acquired harder beaks to crack nuts, as the parrot. Others have acquired beaks adapted to break the harder ſeeds, as ſparrows. Others for the ſofter ſeeds of flowers, or the buds of trees, as the finches. Other birds have acquired long beaks to penetrate the moiſter ſoils in ſearch of inſects or roots, as woodcocks; and others broad ones to filtrate the water of lakes, and to retain aquatic inſects, as ducks. All which ſeem to have been gradually produced during many generations by the perpetual endeavour of the creatures to ſupply the want of food, and to have been delivered to their poſterity with conſtant improvement of them for the purpoſes required.

The third great want amongſt animals is that of ſecurity, which ſeems much to have diverſified the forms of their bodies and the colour of them; theſe conſiſt in the means of eſcaping other animals more powerful than themſelves. Hence ſome animals have acquired wings inſtead of legs, as the ſmaller birds, for the purpoſe of eſcape. Others great length of fin, or of membrane, as the flying fiſh, and the bat. Others great ſwiftneſs of foot, as the hare. Others have acquired hard or armed ſhells, as the tortoiſe and the echinus marinus.

Mr. Oſbeck, a pupil of Linnæus, mentions the American frog-fiſh, lophius hiſtrio, which inhabits the large floating iſlands of ſea-weed about the Cape of Good Hope, and has fulcra reſembling leaves, that the fiſhes of prey may miſtake it for the ſea-weed, which it inhabits. Voyage to China, p. 113.

The contrivances for the purpoſes of ſecurity extend even to vegetables, as is ſeen in the wonderful and various means of their concealing or defending their honey from inſects, and their ſeeds from birds. On the other hand ſwiftneſs of wing has been acquired by hawks and ſwallows to purſue their prey; and a proboſcis of admirable ſtructure has been acquired by the bee, the moth, and the humming bird, for the purpoſe of plundering the nectaries of flowers. All which ſeem to have been formed by the original living filament, excited into action by the neceſſities of the creatures, which poſſeſs them, and on which their exiſtence depends.

From thus meditating on the great ſimilarity of the ſtructure of the warm-blooded animals, and at the ſame time of the great changes they undergo both before and after their nativity; and by conſidering in how minute a portion of time many of the changes of animals above deſcribed have been produced; would it be too bold to imagine, that in the great length of time, ſince the earth began to exiſt, perhaps millions of ages before the commencement of the hiſtory of mankind, would it be too bold to imagine, that all warm-blooded animals have ariſen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propenſities, directed by irritations, ſenſations, volitions, and aſſociations; and thus poſſeſſing the faculty of continuing to improve by its own inherent activity, and of delivering down thoſe improvements by generation to its poſterity, world without end?

Sixthly, The cold-blooded animals, as the fiſh-tribes, which are furniſhed with but one ventricle of the heart, and with gills inſtead of lungs, and with fins inſtead of feet or wings, bear a great ſimilarity to each other; but they differ, nevertheleſs, ſo much in their general ſtructure from the warm-blooded animals, that it may not ſeem probable at firſt view, that the ſame living filament could have given origin to this kingdom of animals, as to the former. Yet are there ſome creatures, which unite or partake of both theſe orders of animation, as the whales and ſeals; and more particularly the frog, who changes from an aquatic animal furniſhed with gills to an aerial one furniſhed with lungs.

The numerous tribes of inſects without wings, from the ſpider to the ſcorpion, from the flea to the lobſter; or with wings, from the gnat and the ant to the waſp and the dragon-fly, differ ſo totally from each other, and from the red-blooded claſſes above deſcribed, both in the forms of their bodies, and their modes of life; beſides the organ of ſenſe, which they ſeem to poſſeſs in their antennæ or horns, to which it has been thought by ſome naturaliſts, that other creatures have nothing ſimilar; that it can ſcarcely be ſuppoſed that this nation of animals could have been produced by the ſame kind of living filament, as the red-blooded claſſes above mentioned. And yet the changes which many of them undergo in their early ſtate to that of their maturity, are as different, as one animal can be from another. As thoſe of the gnat, which paſſes his early ſtate in water, and then ſtretching out his new wings, and expanding his new lungs, riſes in the air; as of the caterpillar, and bee-nymph, which feed on vegetable leaves or farina, and at length burſting from their ſelf-formed graves, become beautiful winged inhabitants of the ſkies, journeying from flower to flower, and nouriſhed by the ambroſial food of honey.

There is ſtill another claſs of animals, which are termed vermes by Linnæus, which are without feet, or brain, and are hermaphrodites, as worms, leeches, ſnails, ſhell-fiſh, coralline inſects, and ſponges; which poſſeſs the ſimpleſt ſtructure of all animals, and appear totally different from thoſe already deſcribed. The ſimplicity of their ſtructure, however, can afford no argument againſt their having been produced from a living filament as above contended.

Laſt of all the various tribes of vegetables are to be enumerated amongſt the inferior orders of animals. Of theſe the anthers and ſtigmas have already been ſhewn to poſſeſs ſome organs of ſenſe, to be nouriſhed by honey, and to have the power of generation like inſects, and have thence been announced amongſt the animal kingdom in Sect. XIII. and to theſe muſt be added the buds and bulbs which conſtitute the viviparous offſpring

ſpring of vegetation. The former I ſuppoſe to be beholden to a ſingle living filament for their ſeminal or amatorial procreation; and the latter to the ſame cauſe for their lateral or branching generation, which they poſſeſs in common with the polypus, tænia, and volvox; and the ſimplicity of which is an argument in favour of the ſimilarity of its cauſe.

Linnæus ſuppoſes, in the Introduction to his Natural Orders, that very few vegetables were at firſt created, and that their numbers were increaſed by their intermarriages, and adds, ſuadent hæc Creatoris leges a ſimplicibus ad compoſita. Many other changes ſeem to have ariſen in them by their perpetual conteſt for light and air above ground, and for food or moiſture beneath the ſoil. As noted in Botanic Garden, Part II. Note on Cuſcuta. Other changes of vegetables from climate, or other cauſes, are remarked in the Note on Curcuma in the ſame work. From theſe one might be led to imagine, that each plant at firſt conſiſted of a ſingle bulb or flower to each root, as the gentianella and daiſy; and that in the conteſt for air and light new buds grew on the old decaying flower ſtem, ſhooting down their elongated roots to the ground, and that in proceſs of ages tall trees were thus formed, and an individual bulb became a ſwarm of vegetables. Other plants, which in this conteſt for light and air were too ſlender to riſe by their own ſtrength, learned by degrees to adhere to their neighbours, either by putting forth roots like the ivy, or by tendrils like the vine, or by ſpiral contortions like the honey-ſuckle; or by growing upon them like the miſleto, and taking nouriſhment from their barks; or by only lodging or adhering on them, and deriving nouriſhment from the air, as tillandſia.

Shall we then ſay that the vegetable living filament was originally different from that of each tribe of animals above deſcribed? And that the productive living filament of each of thoſe tribes was different originally from the other? Or, as the earth and ocean were probably peopled with vegetable productions long before the exiſtence of animals; and many families of theſe animals long before other families of them, ſhall we conjecture that one and the ſame kind of living filaments is and has been the cauſe of all organic life?

If this gradual production of the ſpecies and genera of animals be aſſented to, a contrary circumſtance may be ſuppoſed to have occurred, namely, that ſome kinds by the great changes of the elements may have been deſtroyed. This idea is ſhewn to our ſenſes by contemplating the petrifactions of ſhells, and of vegetables, which may be ſaid, like buſts and medals, to record the hiſtory of remote times. Of the myriads of belemnites, cornua ammonis, and numerous other petrified ſhells, which are found in the maſſes of limeſtone, which have been produced by them, none now are ever found in our ſeas, or in the ſeas of other parts of the world, according to the obſervations of many naturaliſts. Some of whom have imagined, that moſt of the inhabitants of the ſea and earth of very remote times are now extinct; as they ſcarcely admit, that a ſingle foſſil ſhell bears a ſtrict ſimilitude to any recent ones, and that the vegetable impreſſions or petrifactions found in iron-ores, clay, or ſandſtone, of which there are many of the fern kind, are not ſimilar to any plants of this country, nor accurately correſpond with thoſe of other climates, which is an argument countenancing the changes in the forms, both of animals and vegetables, during the progreſſive ſtructure of the globe, which we inhabit. See Townſon's Philoſ. of Mineralogy, p. 110.

This idea of the gradual formation and improvement of the animal world accords with the obſervations of ſome modern philoſophers, who have ſuppoſed that the continent of America has been raiſed out of the ocean at a later period of time than the other three quarters of the globe, which they deduce from the greater comparative heights of its mountains, and the conſequent greater coldneſs of its reſpective climates, and from the leſs ſize and ſtrength of its animals, as the tygers and allegators compared with thoſe of

Aſia or Africa. And laſtly, from the leſs progreſs in the improvements of the mind of its inhabitants in reſpect to voluntary exertions.

This idea of the gradual formation and improvement of the animal world ſeems not to have been unknown to the ancient philoſophers. Plato having probably obſerved the reciprocal generation of inferior animals, as ſnails and worms, was of opinion, that mankind with all other animals were originally hermaphrodites during the infancy of the world, and were in proceſs of time ſeparated into male and female. The breaſts and teats of all male quadrupeds, to which no uſe can be now aſſigned, adds perhaps ſome ſhadow of probability to this opinion. Linnæus excepts the horſe from the male quadrupeds, who have teats; which might have ſhewn the earlier origin of his exiſtence; but Mr. J. Hunter aſſerts, that he has diſcovered the veſtiges of them on his ſheath, and has at the ſame time enriched natural hiſtory with a very curious fact concerning the male pigeon; at the time of hatching the eggs both the male and female pigeon undergo a great change in their crops; which thicken and become corrugated, and ſecrete a kind of milky fluid, which coagulates, and with which alone they for a few days feed their young, and afterwards feed them with this coagulated fluid mixed with other food. How this reſembles the breaſts of female quadrupeds after the production of their young! and how extraordinary, that the male ſhould at this time give milk as well as the female! See Botanic Garden, Part II. Note on Curcuma.

The late Mr. David Hume, in his poſthumous works, places the powers of generation much above thoſe of our boaſted reaſon; and adds, that reaſon can only make a machine, as a clock or a ſhip, but the power of generation makes the maker of the machine; and probably from having obſerved, that the greateſt part of the earth has been formed out of organic recrements; as the immenſe beds of limeſtone, chalk, marble, from the ſhells of fiſh; and the extenſive provinces of clay, ſandſtone, ironſtone, coals, from decompoſed vegetables; all which have been firſt produced by generation, or by the ſecretions of organic life; he concludes that the world itſelf might have been generated, rather than created; that is, it might have been gradually produced from very ſmall beginnings, increaſing by the activity of its inherent principles, rather than by a ſudden evolution of the whole by the Almighty fiat.—What a magnificent idea of the infinite power of the THE GREAT ARCHITECT! THE CAUSE OF CAUSES! PARENT OF PARENTS! ENS ENTIUM!

For if we may compare infinities, it would ſeem to require a greater infinity of power to cauſe the cauſes of effects, than to cauſe the effects themſelves. This idea is analogous to the improving excellence obſervable in every part of the creation; ſuch as in the progreſſive increaſe of the ſolid or habitable parts of the earth from water; and in the progreſſive increaſe of the wiſdom and happineſs of its inhabitants; and is conſonant to the idea of our preſent ſituation being a ſtate of probation, which by our exertions we may improve, and are conſequently reſponſible for our actions.

V. 1. The efficient cauſe of the various colours of the eggs of birds, and of the hair and feathers of animals, is a ſubject ſo curious, that I ſhall beg to introduce it in this place. The colours of many animals ſeem adapted to their purpoſes of concealing themſelves either to avoid danger, or to ſpring upon their prey. Thus the ſnake and wild cat, and leopard, are ſo coloured as to reſemble dark leaves and their lighter interſtices; birds reſemble the colour of the brown ground, or the green hedges, which they frequent; and moths and butterflies are coloured like the flowers which they rob of their honey. Many inſtances are mentioned of this kind in Botanic Garden, Part II. Note on Rubia.

Theſe colours have, however, in ſome inſtances another uſe, as the black diverging area from the eyes of the ſwan; which, as his eyes are placed leſs prominent than thoſe of other birds, for the convenience of putting down his head under water, prevents the rays of light from being reflected into his eye, and thus dazzling his ſight, both in air and beneath the water; which muſt have happened, if that ſurface had been white like the reſt of his feathers.

There is a ſtill more wonderful thing concerning theſe colours adapted to the purpoſe of concealment; which is, that the eggs of birds are ſo coloured as to reſemble the colour of the adjacent objects and their interſtices. The eggs of hedge-birds are greeniſh with dark ſpots; thoſe of crows and magpies, which are ſeen from beneath through wicker neſts, are white with dark ſpots; and thoſe of larks and partridges are ruſſet or brown, like their neſts or ſituations.

A thing ſtill more aſtoniſhing is, that many animals in countries covered with ſnow become white in winter, and are ſaid to change their colour again in the warmer months, as bears, hares, and partridges. Our domeſticated animals loſe their natural colours, and break into great variety, as horſes, dogs, pigeons. The final cauſe of theſe colours is eaſily underſtood, as they ſerve ſome purpoſes of the animal, but the efficient cauſe would ſeem almoſt beyond conjecture.

Firſt, the choroid coat of the eye, on which the ſemitranſparent retina is expanded, is of different colour in different animals; in thoſe which feed on graſs it is green; from hence there would appear ſome connexion between the colour of the choroid coat and of that conſtantly painted on the retina by the green graſs. Now, when the ground becomes covered with ſnow, it would ſeem, that that action of the retina, which is called whiteneſs, being conſtantly excited in the eye, may be gradually imitated by the extremities of the nerves of touch, or rete mucoſum of the ſkin. And if it be ſuppoſed, that the action of the retina in producing the perception of any colour conſiſts in ſo diſpoſing its own fibres or ſurface, as to reflect thoſe coloured rays only, and tranſmit the others like ſoap-bubbles; then that part of the retina, which gives us the perception of ſnow, muſt at that time be white; and that which gives us the perception of graſs, muſt be green.

Then if by the laws of imitation, as explained in Section XII. 33. and XXXIX. 6. the extremities of the nerves of touch in the rete mucoſum be induced into ſimilar action, the ſkin or feathers, or hair, may in like manner ſo diſpoſe their extreme fibres, as to reflect white; for it is evident, that all theſe parts were originally obedient to irritative motions during their growth, and probably continue to be ſo; that thoſe irritative motions are not liable in a healthy ſtate to be ſucceeded by ſenſation; which however is no uncommon thing in their diſeaſed ſtate, or in their infant ſtate, as in plica polonica, and in very young pen-feathers, which are ſtill full of blood.

It was ſhewn in Section XV. on the Production of Ideas, that the moving organ of ſenſe in ſome circumſtances reſembled the object which produced that motion. Hence it may be conceived, that the rete mucoſum, which is the extremity of the nerves of touch, may by imitating the motions of the retina become coloured. And thus, like the fable of the chameleon, all animals may poſſeſs a tendency to be coloured ſomewhat like the colours they moſt frequently inſpect, and finally, that colours may be thus given to the egg-ſhell by the imagination of the female parent; which ſhell is previouſly a mucous membrane, indued with irritability, without which it could not circulate its fluids, and increaſe in its bulk. Nor is this more wonderful than that a ſingle idea of imagination ſhould in an inſtant colour the whole ſurface of the body of a bright ſcarlet, as in the bluſh of ſhame, though by a very different proceſs. In this intricate ſubject nothing but looſe analogical conjectures can be had, which may however lead to future diſcoveries; but certain it is that both the change of the colour of animals to white in the winters of ſnowy countries, and the ſpots on birds eggs, muſt have ſome efficient cauſe; ſince the uniformity of their production ſhews it cannot ariſe from a fortuitous concurrence of circumſtances; and how is this efficient cauſe to be detected, or explained, but from its analogy to other animal facts?

2. The nutriment ſupplied by the female parent in viviparous animals to their young progeny may be divided into three kinds, correſponding with the age of the new creature. 1. The nutriment contained in the ovum as previouſly prepared for the embryon in the ovary. 2. The liquor amnii prepared for the fetus in the uterus, and in which it ſwims; and laſtly, the milk prepared in the pectoral glands for the new-born child. There is reaſon to conclude that variety of changes may be produced in the new animal from all theſe ſources of nutriment, but particularly from the firſt of them.

The organs of digeſtion and of ſanguification in adults, and afterwards thoſe of ſecretion, prepare or ſeparate the particles proper for nouriſhment from other combinations of matter, or recombine them into new kinds of matter, proper to excite into action the filaments, which abſorb or attract them by animal appetency. In this proceſs we muſt attend not only to the action of the living filament which receives a nutritive particle to its boſom, but alſo to the kind of particle, in reſpect to form, or ſize, or colour, or hardneſs, which is thus previouſly prepared for it by digeſtion, ſanguification, and ſecretion. Now as the firſt filament of entity cannot be furniſhed with the preparative organs above mentioned, the nutritive particles, which are at firſt to be received by it, are prepared by the mother; and depoſited in the ovum ready for its reception. Theſe nutritive particles muſt be ſuppoſed to differ in ſome reſpects, when thus prepared by different animals. They may differ in ſize, ſolidity, colour, and form; and yet may be ſufficiently congenial to the living filament, to which they are applied, as to excite its activity by their ſtimulus, and its animal appetency to receive them, and to combine them with itſelf into organization.

By this firſt nutriment thus prepared for the embryon is not meant the liquor amnii, which is produced afterwards, nor the larger exterior parts of the white of the egg; but the fluid prepared, I ſuppoſe, in the ovary of viviparous animals, and that which immediately ſurrounds the cicatricula of an impregnated egg, and is viſible to the eye in a boiled one.

Now theſe ultimate particles of animal matter prepared by the glands of the mother may be ſuppoſed to reſemble the ſimilar ultimate particles, which were prepared for her own nouriſhment; that is, to the ultimate particles of which her own organization conſiſts. And that hence when theſe become combined with a new embryon, which in its early ſtate is not furniſhed with ſtomach, or glands, to alter them; that new embryon will bear ſome reſemblance to the mother.

This ſeems to be the origin of the compound forms of mules, which evidently partake of both parents, but principally of the male parent. In this production of chimeras the ancients ſeem to have indulged their fancies, whence the ſphinxes, griffins, dragons, centaurs, and minotaurs, which are vaniſhed from modern credulity.

It would ſeem, that in theſe unnatural conjunctions, when the nutriment depoſited by the female was ſo ill adapted to ſtimulate the living filament derived from the male into action, and to be received, or embraced by it, and combined with it into organization, as not to produce the organs neceſſary to life, as the brain, or heart, or ſtomach, that no mule was produced. Where all the parts neceſſary to life in theſe compound animals were formed ſufficiently perfect, except the parts of generation, thoſe animals were produced which are now called mules.

The formation of the organs of ſexual generation, in contradiſtinction to that by lateral buds, in vegetables, and in ſome animals, as the polypus, the tænia, and the volvox, ſeems the chef d'œuvre, the maſter-piece of nature; as appears from many flying inſects, as in moths and butterflies, who ſeem to undergo a general change of their forms ſolely for the purpoſe of ſexual reproduction, and in all other animals this organ is not complete till the maturity of the creature. Whence it happens that, in the copulation of animals of different ſpecies, the parts neceſſary to life are frequently completely formed; but thoſe for the purpoſe of generation are defective, as requiring a nicer organization; or more exact coincidence of the particles of nutriment to the irritabilities or appetencies of the original living filament. Whereas thoſe mules, where all the parts could be perfectly formed, may have been produced in early periods of time, and may have added to the numbers of our various ſpecies of animals, as before obſerved.

As this production of mules is a conſtant effect from the conjunction of different ſpecies of animals, thoſe between the horſe and the female aſs always reſembling the horſe more than the aſs; and thoſe, on the contrary, between the male aſs and the mare, always reſembling the aſs more than the mare; it cannot be aſcribed to the imagination of the male animal which cannot be ſuppoſed to operate ſo uniformly; but to the form of the firſt nutritive particles, and to their peculiar ſtimulus exciting the living filament to ſelect and combine them with itſelf. There is a ſimilar uniformity of effect in reſpect to the colour of the progeny produced between a white man, and a black woman, which, if I am well informed, is always of the mulatto kind, or a mixture of the two; which may perhaps be imputed to the peculiar form of the particles of nutriment ſupplied to the embryon by the mother at the early period of its exiſtence, and their peculiar ſtimulus; as this effect, like that of the mule progeny above treated of, is uniform and conſiſtent, and cannot therefore be aſcribed to the imagination of either of the parents.

Dr. Thunberg obſerves, in his Journey to the Cape of Good Hope, that there are ſome families, which have deſcended from blacks in the female line for three generations. The firſt generation proceeding from an European, who married a tawny ſlave, remains tawny, but approaches to a white complexion; but the children of the third generation, mixed with Europeans, become quite white, and are often remarkably beautiful. Vol. i. p. 112.

When the embryon has produced a placenta, and furniſhed itſelf with veſſels for ſelection of nutritious particles, and for oxygenation of them, no great change in its form or colour is likely to be produced by the particles of ſuſtenance it now takes from the fluid, in which it is immerſed; becauſe it has now acquired organs to alter or new combine them. Hence it continues to grow whether this fluid, in which it ſwims, be formed by the uterus or by any other cavity of the body, as in extra-uterine geſtation; and which would ſeem to be produced by the ſtimulus of the fetus on the ſides of the cavity, where it is found, as mentioned before. And thirdly, there is ſtill leſs reaſon to expect any unnatural change to happen to the child after its birth from the difference of the milk it now takes; becauſe it has acquired a ſtomach, a ſtomach, and lungs, and glands, of ſufficient power to decompoſe and recombine the milk; and thus to prepare from it the various kinds of nutritious particles, which the appetencies of the various fibrils or nerves may require.

From all this reaſoning I would conclude, that though the imagination of the female may be ſuppoſed to affect the embryon by producing a difference in its early nutriment; yet that no ſuch power can affect it after it has obtained a placenta, and other organs; which may ſelect or change the food, which is preſented to it either in the liquor amnii, or in the milk. Now as the eggs in pullets, like the ſeeds in vegetables, are produced gradually, long before they are impregnated, it does not appear how any ſudden effect of imagination of the mother at the time of impregnation can produce any conſiderable change in the nutriment already thus laid up for the expected or deſired embryon. And that hence any changes of the embryon, except thoſe uniform ones in the production of mules and mulattoes, more probably depend on the imagination of the male parent. At the ſame time it ſeems manifeſt, that thoſe monſtrous births, which conſiſt in ſome deficiencies only, or ſome redundancies of parts, originate from the deficiency or redundance of the firſt nutriment prepared in the ovary, or in the part of the egg immediately ſurrounding the cicatricula, as deſcribed above;

and which continues ſome time to excite the firſt living filament into action, after the ſimple animal is completed; or ceaſes to excite it, before the complete form is accompliſhed. The former of theſe circumſtances is evinced by the eggs with double yolks, which frequently happen to our domeſticated poultry, and which, I believe, are ſo formed before impregnation, but which would be well worth attending to, both before and after impregnation; as it is probable, ſomething valuable on this ſubject might be learnt from them. The latter circumſtance, or that of deficiency of original nutriment, may be deduced from reverſe analogy.

There are, however, other kinds of monſtrous births, which neither depend on deficiency of parts, or ſupernumerary ones; nor are owing to the conjunction of animals of different ſpecies; but which appear to be new conformations, or new diſpoſitions of parts in reſpect to each other, and which, like the variation of colours and forms of our domeſticated animals, and probably the ſexual parts of all animals, may depend on the imagination of the male parent, which we now come to conſider.

VI. 1. The nice actions of the extremities of our various glands are exhibited in their various productions, which are believed to be made by the gland, and not previouſly to exiſt as ſuch in the blood. Thus the glands, which conſtitute the liver, make bile; thoſe of the ſtomach make gaſtric acid; thoſe beneath the jaw, ſaliva; thoſe of the ears, ear-wax; and the like. Every kind of gland muſt poſſeſs a peculiar irritability, and probably a ſenſibility, at the early ſtate of its exiſtence; and muſt be furniſhed with a nerve of ſenſe, or of motion, to perceive, and to ſelect, and to combine the particles, which compoſe the fluid it ſecretes. And this nerve of ſenſe which perceives the different articles which compoſe the blood, muſt at leaſt be conceived to be as fine and ſubtile an organ, as the optic or auditory nerve, which perceives light or ſound. See Sect. XIV. 9.

But in nothing is this nice action of the extremities of the blood-veſſels ſo wonderful, as in the production of contagious matter. A ſmall drop of variolous contagion diffuſed in the blood, or perhaps only by being inſerted beneath the cuticle, after a time, (as about a quarter of a lunation,) excites the extreme veſſels of the ſkin into certain motions, which produce a ſimilar contagious material, filling with it a thouſand puſtules. So that by irritation, or by ſenſation in conſequence of irritation, or by aſſociation of motions, a material is formed by the extremities of certain cutaneous veſſels, exactly ſimilar to the ſtimulating material, which cauſed the irritation, or conſequent ſenſation, or aſſociation.

Many glands of the body have their motions, and in conſequence their ſecreted fluids, affected by pleaſurable or painful ideas, ſince they are in many inſtances influenced by ſenſitive aſſociations, as well as by the irritations of the particles of the paſſing blood. Thus the idea of meat, excited in the minds of hungry dogs, by their ſenſe of viſion, or of ſmell, increaſes the diſcharge of ſaliva, both in quantity and viſcidity; as is ſeen in its hanging down in threads from their mouths, as they ſtand round a dinner-table. The ſenſations of pleaſure, or of pain, of peculiar kinds, excite in the ſame manner a great diſcharge of tears; which appear alſo to be more ſaline at the time of their ſecretion, from their inflaming the eyes and eye-lids. The paleneſs from fear, and the bluſh of ſhame, and of joy, are other inſtances of the effects of painful or pleaſurable ſenſations, on the extremities of the arterial ſyſtem.

It is probable, that the pleaſurable ſenſation excited in the ſtomach by food, as well as its irritation, contributes to excite into action the gaſtric glands, and to produce a greater ſecretion of their fluids. The ſame probably occurs in the ſecretion of bile; that is, that the pleaſurable ſenſation excited in the ſtomach, affects this ſecretion by ſenſitive aſſociation, as well as by irritative aſſociation.

And laſtly it would ſeem, that all the glands in the body have their ſecreted fluids affected, in quantity and quality, by the pleaſurable or painful ſenſations, which produce or accompany thoſe ſecretions. And that the pleaſurable ſenſations ariſing from theſe ſecretions may conſtitute the unnamed pleaſure of exiſtence, which is contrary to what is meant by tædium vitæ, or ennui; and by which we ſometimes feel ourſelves happy, without being able to aſcribe it to any mental cauſe, as after an agreeable meal, or in the beginning of intoxication.

Now it would appear, that no ſecretion or excretion of fluid is attended with ſo much agreeable ſenſation, as that of the ſemen; and it would thence follow, that the glands, which perform this ſecretion, are more likely to be much affected by their catenations with pleaſurable ſenſations. This circumſtance is certain, that much more of this fluid is produced in a given time, when the object of its excluſion is agreeable to the mind.

2. A forcible argument, which ſhews the neceſſity of pleaſurable ſenſation to copulation, is, that the act cannot be performed without it; it is eaſily interrupted by the pain of fear or baſhfulneſs; and no efforts of volition or of irritation can effect this proceſs, except ſuch as induce pleaſurable ideas or ſenſations. See Sect. XXXIII. 1. 1.

A curious analogical circumſtance attending hermaphrodite inſects, as ſnails and worms, ſtill further illuſtrates this theory; if the ſnail or worm could have impregnated itſelf, there might have been a ſaving of a large male apparatus; but as this is not ſo ordered by nature, but each ſnail and worm reciprocally receives and gives impregnation, it appears, that a pleaſurable excitation ſeems alſo to have been required.

This wonderful circumſtance of many inſects being hermaphrodites, and at the ſame time not having power to impregnate themſelves, is attended to by Dr. Liſter, in his Exercitationes Anatom. de Limacibus, p. 145; who, amongſt many other final cauſes, which he adduces to account for it, adds, ut tam triſtibus et frigidis animalibus majori cum voluptate perficiatur venus.

There is, however, another final cauſe, to which this circumſtance may be imputed: it was obſerved above, that vegetable buds and bulbs, which are produced without a mother, are always exact reſemblances of their parent; as appears in grafting fruit-trees, and in the flower-buds of the dioiceous plants, which are always of the ſame ſex on the ſame tree; hence thoſe hermaphrodite inſects, if they could have produced young without a mother, would not have been capable of that change or improvement, which is ſeen in all other animals, and in thoſe vegetables, which are procreated by the male embryon received and nouriſhed by the female. And it is hence probable, that if vegetables could only have been produced by buds and bulbs, and not by ſexual generation, that there would not at this time have exiſted one thouſandth part of their preſent number of ſpecies; which have probably been originally mule-productions; nor could any kind of improvement or change have happened to them, except by the difference of ſoil or climate.

3. I conclude, that the imagination of the male at the time of copulation, or at the time of the ſecretion of the ſemen, may ſo affect this ſecretion by irritative or ſenſitive aſſociation, as deſcribed in No. V. 1. of this ſection, as to cauſe the production of ſimilarity of form and of features, with the diſtinction of ſex; as the motions of the chiſſel of the turner imitate or correſpond with thoſe of the ideas of the artiſt. It is not here to be underſtood, that the firſt living fibre, which is to form an animal, is produced with any ſimilarity of form to the future animal; but with propenſities, or appetences, which ſhall produce by accretion of parts the ſimilarity of form, feature, or ſex, correſponding to the imagination of the father.

Our ideas are movements of the nerves of ſenſe, as of the optic nerve in recollecting viſible ideas, ſuppoſe of a triangular piece of ivory. The fine moving fibres of the retina act in a manner to which I give the name of white; and this action is confined to a defined part of it; to which figure I give the name of triangle. And it is a preceding pleaſurable ſenſation exiſting in my mind, which occaſions me to produce this particular motion of the retina, when no triangle is preſent. Now it is probable, that the acting fibres of the ultimate terminations of the ſecreting apertures of the veſſels of the teſtes, are as fine as thoſe of the retina; and that they are liable to be thrown into that peculiar action, which marks the ſex of the ſecreted embryon, by ſympathy with the pleaſurable motions of the nerves of viſion or of touch; that is, with certain ideas of imagination. From hence it would appear, that the world has long been miſtaken in aſcribing great power to the imagination of the female, whereas from this account of it, the real power of imagination, in the act of generation, belongs ſolely to the male. See Sect. XII. 3. 3.

It may be objected to this theory, that a man may be ſuppoſed to have in his mind, the idea of the form and features of the female, rather than his own, and therefore there ſhould be a greater number of female births. On the contrary, the general idea of our own form occurs to every one almoſt perpetually; and is termed conſciouſneſs of our exiſtence, and thus may effect, that the number of males ſurpaſſes that of females. See Sect. XV. 3. 4. and XVIII. 13. And what further confirms this idea is, that the male children moſt frequently reſemble the father in form, or feature, as well as in ſex; and the female moſt frequently reſemble the mother, in feature, and form, as well as in ſex.

It may again be objected, if a female child ſometimes reſembles the father, and a male child the mother, the ideas of the father, at the time of procreation, muſt ſuddenly change from himſelf to the mother, at the very inſtant, when the embryon is ſecreted or formed. This difficulty ceaſes when we conſider, that it is as eaſy to form an idea of feminine features with male organs of reproduction, or of male features with female ones, as the contrary; as we conceive the idea of a ſphinx or mermaid as eaſily and as diſtinctly as of a woman. Add to this, that at the time of procreation the idea of the male organs, and of the female features, are often both excited at the ſame time, by contact, or by viſion.

I aſk, in my turn, is the ſex of the embryon produced by accident? Certainly whatever is produced has a cauſe; but when this cauſe is too minute for our comprehenſion, the effect is ſaid in common language to happen by chance, as in throwing a certain number on dice. Now what cauſe can occaſionally produce the male or female character of the embryon, but the peculiar actions of thoſe glands, which form the embryon? And what can influence or govern theſe actions of the gland, but its aſſociations or catenations with other ſenſitive motions? Nor is this more extraordinary, than that the catenations of irritative motions with the apparent vibrations of objects at ſea ſhould produce ſickneſs of the ſtomach; or that a nauſeous ſtory ſhould occaſion vomiting.

4. An argument, which evinces the effect of imagination on the firſt rudiment of the embryon, may be deduced from the production of ſome peculiar monſters. Such, for inſtance, as thoſe which have two heads joined to one body, and thoſe which have two bodies joined to one head; of which frequent examples occur amongſt our domeſticated quadrupeds, and poultry. It is abſurd to ſuppoſe, that ſuch forms could exiſt in primordial germes, as explained in No. IV. 4. of this ſection. Nor is it poſſible, that ſuch deformities could be produced by the growth of two embryons, or living filaments; which ſhould afterwards adhere together; as the head and tail part of different polypi are ſaid to do (Blumenbach on Generation. Cadell, London); ſince in that caſe one embryon, or living filament, muſt have begun to form one part firſt, and the other another part firſt. But ſuch monſtrous conformations become leſs difficult to comprehend, when they are conſidered as an effect of the imagination, as before explained, on the living filament at the time of its ſecretion; and that ſuch duplicature of limbs was produced by accretion of new parts, in conſequence of propenſities, or animal appetencies, thus acquired from the male parent.

For inſtance, I can conceive, if a turkey-cock ſhould behold a rabbit, or a frog, at the time of procreation, that it might happen, that a forcible or even a pleaſurable idea of the form of a quadruped might ſo occupy his imagination, as to cauſe a tendency in the naſcent filament to reſemble ſuch a form, by the appoſition of a duplicature of limbs. Experiments on the production of mules and monſters would be worthy the attention of a Spallanzani, and might throw much light upon the ſubject, which at preſent muſt be explained by conjectural analogies.

The wonderful effect of imagination, both in the male and female parent, is ſhewn in the production of a kind of milk in the crops both of the male and female pigeons after the birth of their young, as obſerved by Mr. Hunter, and mentioned before. To this ſhould be added, that there are ſome inſtances of men having had milk ſecreted in their breaſts, and who have given ſuck to children, as recorded by Mr. Buffon. This effect of imagination, of both the male and female parent, ſeems to have been attended to in very early times; Jacob is ſaid not only to have placed rods of trees, in part ſtripped of their bark, ſo as to appear ſpotted, but alſo to have placed ſpotted lambs before the flocks, at the time of their copulation. Geneſis, chap. xxx. verſe 40.

5. In reſpect to the imagination of the mother, it is difficult to comprehend, how this can produce any alteration in the fetus, except by affecting

ing the nutriment laid up for its firſt reception, as deſcribed in No. V. 2. of this ſection, or by affecting the nouriſhment or oxygenation with which ſhe ſupplies it afterwards. Perpetual anxiety may probably affect the ſecretion of the liquor amnii into the uterus, as it enfeebles the whole ſyſtem; and ſudden fear is a frequent cauſe of miſcarriage; for fear, contrary to joy, decreaſes for a time the action of the extremities of the arterial ſyſtem; hence ſudden paleneſs ſucceeds, and a ſhrinking or contraction of the veſſels of the ſkin, and other membranes. By this circumſtance, I imagine, the terminations of the placental veſſels are detached from their adheſions, or inſertions, into the membrane of the uterus; and the death of the child ſucceeds, and conſequent miſcarriage.

Of this I recollect a remarkable inſtance, which could be aſcribed to no other cauſe, and which I ſhall therefore relate in few words. A healthy young woman, about twenty years of age, had been about five months pregnant, and going down into her cellar to draw ſome beer, was frighted by a ſervant boy ſtarting up from behind the barrel, where he had concealed himſelf with deſign to alarm the maid-ſervant, for whom he miſtook his miſtreſs. She came with difficulty up ſtairs, began to flood immediately, and miſcarried in a few hours. She has ſince borne ſeveral children, nor ever had any tendency to miſcarry of any of them.

In reſpect to the power of the imagination of the male over the form, colour, and ſex of the progeny, the following inſtances have fallen under my obſervation, and may perhaps be found not very unfrequent, if they were more attended to. I am acquainted with a gentleman, who has one child with dark hair and eyes, though his lady and himſelf have light hair and eyes; and their other four children are like their parents. On obſerving this diſſimilarity of one child to the others he aſſured me, that he believed it was his own imagination, that produced the difference; and related to me the following ſtory. He ſaid, that when his lady lay in of her third child, he became attached to a daughter of one of his inferior tenants, and offered her a bribe for her favours in vain; and afterwards a greater bribe, and was equally unſucceſsful; that the form of this girl dwelt much in his mind for ſome weeks, and that the next child, which was the dark-eyed young lady above mentioned, was exceedingly like, in both features and colour, to the young woman who refuſed his addreſſes.

To this inſtance I muſt add, that I have known two families, in which, on account of an intailed eſtate in expectation, a male heir was moſt eagerly deſired by the father; and on the contrary, girls were produced to the ſeventh in one, and to the ninth in another; and then they had each of them a ſon. I conclude, that the great deſire of a male heir by the father produced rather a diſagreeable than an agreeable ſenſation; and that his ideas dwelt more on the fear of generating a female, than on the pleaſurable ſenſations or ideas of his own male form or organs at the time of copulation, or of the ſecretion of the ſemen; and that hence the idea of the female character was more preſent to his mind than that of the male one; till at length in deſpair of generating a male theſe ideas ceaſed, and thoſe of the male character preſided at the genial hour.

6. Hence I conclude, that the act of generation cannot exiſt without being accompanied with ideas, and that a man muſt have at that time either a general idea of his own male form, or of the form of his male organs; or an idea of the female form, or of her organs; and that this marks the ſex, and the peculiar reſemblances of the child to either parent. From whence it would appear, that the phalli, which were hung round the necks of the Roman ladies, or worn in their hair, might have effect in producing a greater proportion of male children; and that the calipædia, or art of begetting beautiful children, and of procreating either males or females, may be taught by affecting the imagination of the male-parent; that is, by the fine extremities of the ſeminal glands imitating the actions of

the organs of ſenſe either of ſight or touch. But the manner of accompliſhing this cannot be unfolded with ſufficient delicacy for the public eye; but may be worth the attention of thoſe, who are ſeriouſly intereſted in the procreation of a male or female child.

Recapitulation.

VII. 1. A certain quantity of nutritive particles are produced by the female parent before impregnation, which require no further digeſtion, ſecretion, or oxygenation. Such are ſeen in the unimpregnated eggs of birds, and in the unimpregnated ſeed-veſſels of vegetables.

2. A living filament is produced by the male, which being inſerted amidſt theſe firſt nutritive particles, is ſtimulated into action by them; and in conſequence of this action, ſome of the nutritive particles are embraced, and added to the original living filament; in the ſame manner as common nutrition is performed in the adult animal.

3. Then this new organization, or additional part, becomes ſtimulated by the nutritive particles in its vicinity, and ſenſation is now ſuperadded to irritation; and other particles are in conſequence embraced, and added to the living filament; as is ſeen in the new granulations of fleſh in ulcers.

By the power of aſſociation, or by irritation, the parts already produced continue their motions; and new ones are added by ſenſation, as above mentioned; and laſtly by volition, which laſt ſenſorial power is proved to exiſt in the fetus in its maturer age, becauſe it has evidently periods of activity and of ſleeping; which laſt is another word for a temporary ſuſpenſion of volition.

The original living filament may be conceived to poſſeſs a power of repulſing the particles applied to certain parts of it, as well as of embracing others, which ſtimulate other parts of it; as theſe powers exiſt in different parts of the mature animal; thus the mouth of every gland embraces the particles or fluid, which ſuit its appetency; and its excretory duct repulſes thoſe particles, which are diſagreeable to it.

4. Thus the outline or miniature of the new animal is produced gradually, but in no great length of time; becauſe the original nutritive particles require no previous preparation by digeſtion, ſecretion, and oxygenation: but require ſimply the ſelection and appoſition, which is performed by the living filament. Mr. Blumenbach ſays, that he poſſeſſes a human fetus of only five weeks old, which is the ſize of a common bee, and has all the features of the face, every finger, and every toe complete; and in which the organs of generation are diſtinctly ſeen. P. 76. In another fetus, whoſe head was not larger than a

pea, the whole of the baſis of the ſkull with all its depreſſions, apertures, and proceſſes, were marked in the moſt ſharp and diſtinct manner, though without any oſſification. Ib.

5. In ſome caſes by the nutriment originally depoſited by the mother the filament acquires parts not exactly ſimilar to thoſe of the father, as in the production of mules and mulattoes. In other caſes, the deficiency of this original nutriment cauſes deficiencies of the extreme parts of the fetus, which are laſt formed, as the fingers, toes, lips. In other caſes, a duplicature of limbs, is cauſed by the ſuperabundance of this original nutritive fluid, as in the double yolks of eggs, and the chickens from them with four legs and four wings. But the production of other monſters, as thoſe with two heads, or with parts placed in wrong ſituations, ſeems to ariſe from the imagination of the father being in ſome manner imitated by the extreme veſſels of the ſeminal glands; as the colours of the ſpots on eggs, and the change of the colour of the hair and feathers of animals by domeſtication, may be cauſed in the ſame manner by the imagination of the mother.

6. The living filament is a part of the father, and has therefore certain propenſities, or appetencies, which belong to him; which may have been gradually acquired during a million of generations, even from the infancy of the habi-

table earth; and which now poſſeſſes ſuch properties, as would render, by the appoſition of nutritious particles, the new fetus exactly ſimilar to the father; as occurs in the buds and bulbs of vegetables, and in the polypus, and tænia or tape-worm. But as the firſt nutriment is ſupplied by the mother, and therefore reſembles ſuch nutritive particles, as have been uſed for her own nutriment or growth, the progeny takes in part the likeneſs of the mother.

Other ſimilarities of the excitability, or of the form of the male parent, ſuch as the broad or narrow ſhoulders, or ſuch as conſtitute certain hereditary diſeaſes, as ſcrofula, epilepſy, inſanity, have their origin produced in one or perhaps two generations; as in the progeny of thoſe who drink much vinous ſpirits; and thoſe hereditary propenſities ceaſe again, as I have obſerved, if one or two ſober generations ſucceed; otherwiſe the family becomes extinct.

This living filament from the father is alſo liable to have its propenſities, or appetencies, altered at the time of its production by the imagination of the male parent; the extremities of the ſeminal glands imitating the motions of the organs of ſenſe; and thus the ſex of the embryon is produced; which may be thus made a male or a female by affecting the imagination of the father at the time of impregnation. See Sect. XXXIX. 6. 3. and 7.

7. After the fetus is thus completely formed together with its umbilical veſſels and placenta, it is now ſupplied with a different kind of food, as appears by the difference of conſiſtency of the different parts of the white of the egg, and of the liquor amnii, for it has now acquired organs for digeſtion or ſecretion, and for oxygenation, though they are as yet feeble; which can in ſome degree change, as well as ſelect, the nutritive particles, which are now preſented to it. But may yet be affected by the deficiency of the quantity of nutrition ſupplied by the mother, or by the degree of oxygenation ſupplied to its placenta by the maternal blood.

The augmentation of the complete fetus by additional particles of nutriment is not accompliſhed by diſtention only, but by appoſition to every part both external and internal; each of which acquires by animal appetencies the new addition of the particles which it wants. And hence the enlarged parts are kept ſimilar to their prototypes, and may be ſaid to be extended; but their extenſion muſt be conceived only as a neceſſary conſequence of the enlargement of all their parts by appoſition of new particles.

Hence the new appoſition of parts is not produced by capillary attraction, becauſe the whole is extended; whereas capillary attraction would rather tend to bring the ſides of flexible tubes together, and not to diſtend them. Nor is it produced by chemical affinities, for then a ſolution of continuity would ſucceed, as when ſugar is diſſolved in water; but it is produced by an animal proceſs, which is the conſequence of irritation, or ſenſation; and which may be termed animal appetency.

This is further evinced from experiments, which have been inſtituted to ſhew, that a living muſcle of an animal body requires greater force to break it, than a ſimilar muſcle of a dead body. Which evinces, that beſides the attraction of coheſion, which all matter poſſeſſes, and beſides the chemical attractions of affinities, which hold many bodies together, there is an animal adheſion, which adds vigour to theſe common laws of the inanimate world.

8. At the nativity of the child it depoſits the placenta or gills, and by expanding its lungs acquires more plentiful oxygenation from the currents of air, which it muſt now continue perpetually to reſpire to the end of its life; as it now quits the liquid element, in which it was produced, and like the tadpole, when it changes into a frog, becomes an aerial animal.

9. As the habitable parts of the earth have been, and continue to be, perpetually increaſing by the production of ſea-ſhells and corallines, and by the recrements of other animals, and vegetables; ſo from the beginning of the exiſtence of this terraqueous globe, the animals,

which inhabit it, have conſtantly improved, and are ſtill in a ſtate of progreſſive improvement.

This idea of the gradual generation of all things ſeems to have been as familiar to the ancient philoſophers as to the modern ones; and to have given riſe to the beautiful hieroglyphic figure of the *προτον ωον*, or firſt great egg, produced by NIGHT, that is, whoſe origin is involved in obſcurity, and animated by *ερος*, that is, by DIVINE LOVE; from whence proceeded all things which exiſt.

Appendix.

VIII. 1. Since the former publication of the preceding Section on Generation, I have been induced in my treatiſe on Phytologia, to give more attention to the lateral or ſolitary generation of vegetables in the production of their buds, hoping from thence to throw ſome light on their ſexual generation in the production of ſeeds; and in conſequence on the propagation of more perfect animals, which I ſhall here relate, believing that it may intereſt the philoſophical reader, obſerving only, that by the vegetable facts here attended to, I am now induced to believe, that the embryons of complicate animal and vegetable bodies are not formed from a ſingle filament as above delivered; but that their ſtructure commences in many parts at the ſame time, though it is probable, that the moſt ſimple or firſt exordium of animation was begun by a ſingle filament, and continues to do ſo in the ſpontaneous production of the ſmalleſt microſcopic animals, which do not appear to have been generated by other animalcula ſimilar to themſelves, as further ſpoken of in No. 11. 5. of this Section.

1. It is ſhewn at large in the work above mentioned, that every bud of a tree is an individual vegetable, and conſiſts of the plumula or leaf at its ſummit, of a long caudex extending from this ſummit downwards to the earth, forming a filament of the bark, and laſtly of radicles beneath the ſoil: it is alſo ſhewn, that every bud poſſeſſes the power of germination or reproduction, not only in the axilla of the leaf, which is moſt common, but from any part of the long caudex gemmæ above mentioned, as appears from new buds ſpringing out from any part of the bark, when the top of a branch is cut off.

Now if a ſcion of a nonpareil apple be ingrafted on a crab ſtock, and a golden-pippin be ingrafted on the nonpareil, what happens?—The caudex of the bud of the golden-pippin conſiſts of its proper abſorbent veſſels, arteries, and veins, till it reaches down to the nonpareil ſtock; and then the continuation of its caudex downwards conſiſts of veſſels ſimilar to thoſe of the nonpareil; and when its caudex deſcends ſtill lower, it conſiſts of veſſels ſimilar to thoſe of the crab-ſtock.

The truth of this is ſhewn by two circumſtances; firſt, becauſe the lower parts of this compound tree will occaſionally put forth buds ſimilar to the original ſtock. And ſecondly, becauſe in ſome ingrafted trees, where a quick-growing ſcion has been inſerted into a ſtock of ſlower growth, as is often ſeen in old cherry-trees, the upper part of the trunk of the tree has become of almoſt double the diameter of the lower part. Both which occurrences ſhew, that the lower part of the trunk of the tree continues to be of the ſame kind, though it muſt have been ſo repeatedly covered over with new circles of wood, bark, and cuticle.

Now as the caudex of each bud, which paſſes the whole length of the trunk of the tree, and forms a communication from the upper part or plumula, to the lower part or radicle, muſt conſiſt in theſe doubly ingrafted trees of three different kinds of caudexes, reſembling thoſe of the different ſtocks or ſcions; we acquire a knowledge of what may be termed a lateral or paternal mule, in contradiſtinction to a ſexual mule. For as in theſe trees thus combined by ingraftment every bud has the upper part of its caudex that of a golden-pippin, the middle part of it that of a nonparcil, and the lower part of it that of a crab; if theſe caudexes, which conſtitute the filaments of the bark could be ſeparated intire from the tree with their plumules and radicles, they would exhibit ſo many lateral or paternal mules, conſiſting of the connected parts of their three parents; the plumula belonging to the upper parent, and the radicle to the lower one, and the triple caudex to them all.

A ſeparation of theſe buds from the parent plant is ſaid to have been obſerved by Mr. Blumenbach, in the conferva fontinalis, a vegetable which conſiſts of ſmall ſhort ſlender threads, which grow in our fountains, and fix their roots in the mud. He obſerved by magnifying glaſſes, that the extremities of the threads ſwell, and form ſmall tubera or heads; which gradually ſeparate from the parent threads, attach themſelves to the ground, and become perfect vegetables; the whole progreſs of their formation can be obſerved in forty-eight hours. Obſervations on plants by Von Uſlar. Creech, Edinb.

2. The lateral propagation of the polypus found in our ditches in July, but more particularly that of the hydra ſtentorea, is wonderfully analogous to the above idea of the lateral generation of vegetables. The hydra ſtentorea, according to the account of Monſ. Trembley, multiplies itſelf by ſplitting lengthwiſe; and in twenty-four hours theſe diviſions, which adhere to a common pedicle, reſplit, and form four diſtinct animals, Theſe four in an equal time ſplit

again, and thus double their number daily; till they acquire a figure ſomewhat reſembling a noſegay. The young animals afterwards ſeparate from the parent, attach themſelves to aquatic plants, and give riſe to new colonies.

Another curious animal fact is related by Blumenbach in his Treatiſe on Generation concerning the freſh water polypus. He cut two of them in halves, which were of different colours, and applying the upper part of one to the lower part of the other by means of a glaſs tube, and retaining them thus for ſome time in contact with each other, the two divided extremities united, and became one animal. The facil union of the divided halves of different polypi is alſo aſſerted by Mr. Adams. Treatiſe on Microſcopes.

The intelligent reader has already anticipated me in applying theſe wonderful modes of lateral animal reproduction and conjunction, to the lateral propagation and ingraftment of vegetables. The junction of the head part of one polypus to the tail-part of another is exactly repreſented by the ingraftment of a ſcion on the ſtock of another tree, the plumula or apex of each bud with the upper part of its caudex joins to the long caudex of the ſtock, which paſſing down the trunk terminates in the radicles of it. And if this compound vegetable could be ſeparated longitudinally from the other long filaments of the bark in its vicinity, like the fibres of the bark of the mulberry tree prepared at Otaheite, or as the bark of hemp and flax are prepared in this country, as the young ones of the hydra ſtentorea ſeparate from their parents, it might claim the name of a lateral or paternal mule, as above mentioned.

3. It hence appears, that every new bud of a tree, where two ſcions have been inſerted over each other on a ſtock, if it could be ſeparated from the plume to the radicle, muſt conſiſt of three different kinds of caudex; and might therefore be called a triple lateral mule. And that hence it follows, that every part of this new triple caudex muſt have been ſeparated or ſecreted laterally from the adjoining part of the trunk of the tree; and that it could not be formed, as I formerly believed, from the roots of the plume of the bud deſcending from the upper part of the caudex of it to the earth. A circumſtance of great importance in the inveſtigation of the curious ſubject of the lateral generation of vegetables, and of inſects.

One might hence ſuſpect, that if Blumenbach had attended to the propagation of the polypus, which he had compoſed of two half polypi, that the young progeny might have poſſeſſed two colours reſembling the compound parent, like the different caudexes of ingrafted trees; an experiment well worthy repeated obſervation.

4. Another animal fact ought alſo to be here

mentioned, that many inſects, as common earth worms as well as the polypus, are ſaid to poſſeſs ſo much life throughout a great part of their ſyſtem; that they may be cut into two or more pieces without deſtroying them; as each piece will acquire a new head, or a new tail, or both, and the inſect will thus become multiplied! How exactly this is reſembled by the long caudex of the buds of trees; which poſſeſs ſuch vegetable life from one extremity to the other, that when the head or plume is lopped off, it can produce a new plume, and when the lower part is cut off, it can produce new radicles; and may be thus wonderfully multiplied!

This curious vegetable phenomenon is worthy our attention and remembrance; for as each filament of the new bark of a tree conſtitutes a caudex of an embryon bud; when the ſummit of a twig is lopped off, which contained the plumules or embryon leaves of many of them; each embryon caudex can generate new plumules or embryon leaves; and new radicles, when the lower part of a twig is cut off, and the upper part planted; which demonſtrates, that the primary parts of a vegetable embryon may produce ſecondary parts; and that hence it is not neceſſary, that the whole of an animal fetus ſhould be formed at the ſame time.

5. Hence we acquire ſome new and important ideas concerning the lateral generation of vegetables,

tables, and which may probably contribute to elucidate their ſexual generation. Theſe are, firſt, that the parts of the long caudex of each new bud of an ingrafted tree, and conſequently of all trees, are ſeparated or ſecreted from the correſpondent or adjoining parts of the long caudex of the laſt year's bud, which was its parent. And not that it conſiſts of the roots of each new bud ſhot down from the plumula or apex of it; as I formerly ſuppoſed. And that theſe various molecules or fibrils ſecreted from the caudex of the laſt year's buds adjoin and grow together beneath the cuticle of the trunk of the tree; the upper ones forming the plumula of the new bud, which is its leaf or lungs to acquire oxygen from the atmoſphere; and the lower ones forming the radicles of it, which are abſorbent veſſels to acquire nutriment from the earth.

Secondly, that every part of the caudex of an ingrafted tree, and conſequently of all trees, can generate or produce a new plumula, when the upper part of it is ſtrangulated with a wire or cut off; or otherwiſe when it is ſupplied more abundantly with nutriment, ventilation, and light. And that each of theſe new buds thus produced reſembles that part of the ſtock in compound trees, where it ariſes. Thus in the triple tree above mentioned a bud from the upper part of the long caudexes, which form the filaments of the bark, would become a golden-pippin branch, a bud

from

from the middle part of them would become a nonpareil branch, and a bud from the lower part a crab branch.

Thirdly, another wonderful property of this lateral mule progeny of trees compounded by ingraftment conſiſts in this, that the new mule may conſiſt of parts from three or four or many parents; when ſo many different ſcions are ingrafted on each other, whence a queſtion may ariſe, whether a mixture of two kinds of anther-duſt previous to its application to the ſtigma of flowers might not produce a threefold mule partaking of the likeneſs of both the males?

6. On this nice ſubject of reproduction, ſo far removed from common apprehenſion, the patient reader will excuſe a more prolix inveſtigation. The attraction of all matter to the centres of the planets, or of the ſun, is termed gravitation, that of particular bodies to each other is generally called chemical affinity; to which the attractions belonging to electricity and magnetiſm appear to be allied.

In theſe latter kinds of attraction two circumſtances ſeem to be required, firſt, the power to attract poſſeſſed by one of the bodies, and ſecondly, the aptitude to be attracted poſſeſſed by the other. Thus when a magnet attracts iron, it may be ſaid to poſſeſs a ſpecific tendency to unite with iron; and the iron may be ſaid to poſſeſs a ſpecific aptitude to be united with the magnet.

net. The former appears to reſide in the magnet, becauſe it can be deprived of its attractive power, which can alſo be reſtored to it. And the iron appears to poſſeſs a ſpecific aptitude to be united with the magnet, becauſe no other metal will approach it. In the ſame manner a rubbed glaſs tube or a rubbed ſtick of ſealing wax may be ſaid to poſſeſs a ſpecific tendency to unite with a light ſtraw, or hair, and the ſtraw or hair to poſſeſs a ſpecific aptitude to unite with the rubbed glaſs or ſealing wax; becauſe the ſpecific attraction to the rubbed glaſs or ſealing wax can be withdrawn or reſtored; to which may be added, that ſome chemical combinations may ariſe from the ſingle attraction of one body, and the aptitude to be attracted of another. Or they may be owing to reciprocal attractions of the two bodies, as in what is termed by the chemiſts double affinity, which is known to be ſo powerful as to ſeparate thoſe bodies, which are held together by the ſimple attraction probably of one of them to the other; which other poſſeſſes only an aptitude to be attracted by the former.

It is probable, that in ſome of the moſt ſimple combinations of the particles of inanimate matter, two of them may be ſtrongly united by reciprocal attractions to each other; that in other ſimple combinations two particles may be held together, though leſs firmly, by the attraction of one and the aptitude to be attracted of the other. Thus I ſuſpect that carbon and oxygen ruſh together by their reciprocal attractions producing exploſion, and being afterwards not eaſily ſeparable; while azote or nitrogen is leſs firmly united with oxygen by the attraction of one of them, and only the aptitude to be attracted of the other. If this circumſtance could be nicely aſcertained, the theory of chemical affinities might poſſibly advance a ſtep further in the explanation of ſome difficult phenomena, as of the heat generated in the exploſion of various materials, with which oxygen is more looſely united, when applied to ignited carbon; as of the acid of nitre, and ſeveral metallic oxydes; as well as of the general circumſtances of combuſtion and inflammation, as of phoſphorus in the atmoſphere, and of oil of cloves with nitrous acid.

7. The above account of the tendencies to union of unorganized or inanimate matter is not given as a philoſophical analogy, but to facilitate our conception of the adjunctions or concretions obſervable in organized or animated bodies; which conſtitute their formation, their nutrition, and their growth. Theſe may be divided into two kinds; firſt the junction or union of animated bodies with inanimate matter, as when fruit or fleſh is ſwallowed into the ſtomach, and becomes abſorbed by the lacteals; and the ſecond, where living particles coaleſce or concrete together; as

in the formation, nutrition, or conjunction of the parts of living animals.

In reſpect to the former the animal parts, as the noſtrils and palate, poſſeſs an appetency, when ſtimulated by the ſcent and flavour of agreeable food, to unite themſelves with it; and the inanimate material poſſeſſes an aptitude to be thus united with the animal organ. The ſame occurs, when the food is ſwallowed into the ſtomach; the mouths of the lacteal veſſels being agreeably ſtimulated poſſeſs an appetency to abſorb the particles of the digeſting maſs; which is in a ſituation of undergoing chemical changes, and poſſeſſes at ſome period of them an aptitude to ſtimulate, and to be united with the mouths of the abſorbent lacteals.

But when theſe abſorbed particles of inanimate matter have been circulated in the blood, they ſeem gradually to obtain a kind of vitality; whence Mr. John Hunter, and I believe ſome antient philoſophers, and the divine Moſes, aſſerted, that the blood is alive; that is, that it poſſeſſes ſome degree of organization, or other properties, different from thoſe of inanimate matter; which are not producible by any chemical proceſs, and which ceaſe to exiſt along with the life of the animal. Hence for the purpoſe of nutrition there is reaſon to ſuſpect, that two circumſtances are neceſſary, both dependant upon life, and conſequent activity; theſe are firſt an appetency of the fibrils of the fixed organization, which wants nutrition; and ſecondly a propenſity of the fluid molecules exiſting in the blood, or ſecreted from it, to unite with the organ now ſtimulated into action. So that nutrition may be ſaid to be effected by the embrace or coaleſcence of the fibrils, which poſſeſs nutritive appetencies, with the molecules, which poſſeſs nutritive propenſities, or in other words of particles, which poſſeſs reciprocal appetencies to embrace each other.

8. If the philoſopher, who thinks on this ſubject, ſhould not be inclined to believe, that the whole of the blood is alive, he cannot eaſily deny life to that part of it, which is ſecreted by the organs of generation, and conveys vitality to the new embryon, which it produces. Hence though in the proceſs of nutrition the activity of two kinds of fibrils or molecules may be ſuſpected, yet in the proceſs of the generation of a new vegetable or animal, there ſeems great reaſon to believe, that both the combining and combined particles are endued with vitality; that is, with ſome degree of organization or other properties not exiſting in inanimate matter, which we beg leave to denominate fibrils with formative appetencies, and molecules with formative propenſities; as the former may ſeem to poſſeſs a greater degree of organization than the latter.

And thus it appears, that though nutrition may be conceived to be produced by the animated fibrils of an organized part being ſtimulated into action by inanimate molecules, which they then embrace; and may thus be popularly compared to the ſimple attractions of chemiſtry; yet that in the production of a new embryon, whether vegetable or animal, both the fibrils with formative appetencies and the molecules with formative propenſities reciprocally ſtimulate and embrace each other, and inſtantly coaleſce; and may thus popularly be compared to the reciprocal attractions of ſome of the atoms of inanimate matter, or to the double affinities of chemiſtry. But there are animal facts, which may be compared to both theſe, and are thence more philoſophically analogous to them; and theſe are the two great ſupports of animated nature, the paſſions of hunger and of love. In the former the appetency reſides only in the ſtomach, or perhaps in the cardia ventriculi, but the object conſiſts of inanimate matter; in the latter there exiſt reciprocal appetencies and propenſities in the male and female, which mutually excite them to embrace each other. Two other animal facts are equally analogous; the thirſt, which reſides at the upper end of the eſophagus, and though it poſſeſſes appetency itſelf, its object is inanimate matters; but in lacteſcent females, when they give ſuck to their young, there exiſts a reciprocal appetency in the mother to part with her milk, and in the young offspring to receive it.

This then finally I conceive to be the manner of the production of the lateral progeny of vegetables. The long caudex of an exiſting bud of a tree, which conſtitutes a ſingle filament of the preſent bark, is furniſhed with glands numerous as the perſpirative or mucous glands of animal bodies; and that theſe are of two kinds, the one ſecreting from the vegetable blood the fibrils with formative appetencies, correſpondent to the maſculine ſecretion of animals; and the other ſecreting from the vegetable blood the molecules with formative propenſities, correſpondent to the feminine ſecretion of animals, and then that both theſe kinds of formative particles are depoſited beneath the cuticle of the bark along the whole courſe of it, and inſtantly embrace and coaleſce, forming a new caudex along the ſide of its parent, with vegetable life, and with the additional powers of nutrition, and of growth.

9. This then is the great ſecret of nature. More living particles, ſome with appetencies, and ſome with propenſities, are produced by the powers of vitality in the fabrication of the vegetable blood, than are neceſſary for nutrition, or for the reſtoration of decompoſing organs. Theſe are ſecreted by different glands, and detruded externally, and produce by their combination a new vital organization beneath the cuticles of trees over the old one. Theſe new combinations of vital fibrils and moleculcs acquire new appeten-

cies, and ſabricate molecules with new propenſities; and thus poſſeſs the power of forming the leaf or lungs at one extremity of the new caudex; and the radicles or abſorbent veſſels at the other end; and ſome of them, as in the central buds, which terminate the branches, finally form the ſexual organs of reproduction, which conſtitute the flower; all which are ſecondary parts of the new embryon or fetus, as ſhewn in number 9. 4. of this ſection.

That new organizations of the growing ſyſtem acquire new appetencies appears from the production of the paſſion for generation, as ſoon as the adapted organs are complete, and alſo from the variation of the palate, or deſire for particular kinds of food, as we advance in life, as from milk to fleſh; thus as a popular allуſion, not as a philoſophical analogy, we may again be allowed to apply to the combinations of chemiſtry. Where two different kinds of particles unite, as acids and alcalies, a third ſomething is produced, which poſſeſſes attractions diſſimilar to thoſe of either of them.

And that new organizations form new molecules, appears from the ſecretions of the ſeminal and uterine glands, when they have acquired their maturity; and from the pectoral ones of lacteſcent females.

10. In the lateral propagation of vegetable buds, as the ſuperfluous fibrils or molecules,

which were fabricated in the blood, or detached from living organs, and poſſeſs nutritive or formative appetencies and propenſities; and which were more abundant, than were required for the nutrition of the parent vegetable bud, when it had obtained its full growth, were ſecreted by innumerable glands on the various parts of its ſurface beneath the general cuticle of the tree, and there embracing and coaleſcing form a new embryon caudex, which gradually produces a new plumula and radicles. And as the different parts of the new caudex of a compound tree reſemble the parts of the parent caudex, to which it adheres, this important circumſtance is ſhewn beyond all doubt, that different fibrils or molecules were detached from different parts of the parent caudex to form the filial one.

So in the ſexual propagation of vegetables the ſuperfluous living fibrils or molecules detached from various parts of the ſyſtem, and floating in the blood, appear to be ſecreted from it by two kinds of glands only, thoſe which conſtitute the anthers, and thoſe which conſtitute the pericarp of flowers. By the former I ſuppoſe the fibrils with formative appetencies and with nutritive appetencies to be ſecreted; and by the latter the molecules with formative and with nutritive propenſities. Afterwards, that theſe fibrils with formative and nutritive appetencies become mixed in the pericarp of the flower with the correſpondent molecules with formative and nutritive propenſities, and that a new embryon is inſtantly produced by their reciprocal embrace and coaleſcence.

And that parts of this new organization afterwards acquire new appetencies, and form new molecules, and thus gradually produce other parts of the growing ſeed, which do not at firſt appear, as the plumula, radicles, cuticle, and the glands of reproduction in the pericarp and anthers, which correſpond in the animal fetus to the lungs, inteſtines, cuticle, and the organs, which diſtinguiſh the ſexes, and are their parts of ſecondary formation.

If ſecondary parts of a vegetable embryon were not fabricated from the primary parts, or firſt rudiments of it, the flowers of the claſs diœcia of Linneus could not produce both male and female ſeeds, as the male and female organs of reproduction reſide on different plants. For as the male plants produce buds ſimilar to themſelves, which may be termed male buds; and the female plants produce buds ſimilar to themſelves, which may be termed female buds, it would ſeem impoſſible for the flowers to generate female ſeeds according to the theory of reproduction above delivered. As the male, not being an hermaphrodite, cannot be ſuppoſed to ſecrete any fibrils with appetencies proper to produce female organs, as no ſuch can exiſt in his blood, which muſt therefore be fabricated afterwards by the new appetencies acquired by the new organizations of the growing embryon.

11. From this new doctrine of a three-fold vegetable mule by lateral propagation, as the new bud of a tree, which has had two ſcions ingrafted on it one above another; in which it is inconteſtibly ſhewn, that different fibrils or molecules are detached from different parts of the parent caudex to form the filial one, which adheres to it; we may ſafely conclude, as it is deducible from the ſtrongeſt analogy, that in the production of ſexual mules, ſome parts of the new embryon were produced by, or detached from, ſimilar parts of the parent, which they reſemble. And that as theſe fibrils or molecules floated in the circulating blood of the parents, they were collected ſeparately by appropriated glands of the male or female; and that finally on their mixture in the matrix the new embryon was generated, reſembling in ſome parts the form of the father, and in other parts the form of the mother, according to the quantity or activity of the fibrils or molecules at the time of their conjunction.

And laſtly, that various parts of the new organizations afterwards acquired new appetencies, and formed molecules with new propenſities, and thus gradually produced other ſecondary parts of the growing fetus, as the ſkin, nails, hair, and the organs, which diſtinguiſh the ſexes.

If the molecules ſecreted by the female organ into the pericarp of flowers, or into the ovary of animals, were ſuppoſed to conſiſt of only unorganized or inanimate particles; and the fibrils ſecreted by the male organ only to poſſeſs formative appetencies to ſelect and combine with them; the new embryon muſt probably have always reſembled the father, and no mules could have had exiſtence.

But by the theory above delivered it appears, that the new offspring, both in vegetable and animal reproduction, whether it be a mule or not, muſt ſometimes more reſemble the male parent, and ſometimes the female one, and ſometimes to be a combination of them both, as in the Epigram of Martial.

> Dum dubitat natura gravis puerum faceretne puellam,
> Factus es, O pulcher, pene puella, puer.

IX. 1. The foregoing remarks on vegetable generation are chiefly tranſcribed from my work on Phytologia, Sect. VII. and may be applied to animal reproduction; ſince from this analogy to the lateral propagation of vegetable buds, if we ſuppoſe, that redundant fibrils with formative appetencies are produced by, or detached from, various parts of the male animal, and circulating in his blood, are ſecreted by adapted glands, and conſtitute the ſeminal fluid; and that redundant molecules with formative aptitudes or propenſities are produced by, or detached from, various parts of the female, and circulating in her blood, are ſecreted by adapted glands, and form a reſervoir in the ovary; and finally that when theſe formative fibrils, and formative molecules, become mixed together in the uterus, that they coaleſce or embrace each other, and form different parts of the new embryon, as in the cicatricula of the impregnated egg; we may more readily comprehend ſome circumſtances, which are difficult to underſtand on any other ſyſtem of generation.

It muſt be obſerved, that this theory differs from that of M. Buffon; as he conceives the ſame organized particles to exiſt in the generative ſecretions both of the male and female parent; whereas in this theory it is ſuppoſed, that particles completely organized are too large to paſs the glands of either ſex, and that thoſe, which are ſeen in the ſemen by microſcopes, are the conſequence of the ſtagnation of the fluid, as in the puſtules of the itch, and in the liquid feces of dyſenteric patients. Hence the fibrils with formative appetencies and the molecules with formative aptitudes or propenſities muſt coaleſce to produce the firſt organization.

Secondly, in M. Buffon's theory the fetus is ſuppoſed to be inſtantaneouſly produced all at once; whereas in our theory there is believed to exiſt a primary, and ſecondary formation; that is, that many eſſential parts, as the brain and the heart, are primarily produced from the congreſs of the fibrils with formative appetencies, and the molecules with formative aptitudes or propenſities; and that theſe combinations acquire new appetencies, and produce or unite with molecules with new aptitudes, and thus generate other parts of ſecondary formation, as ribs, fingers, inteſtines, with the external form, and the glands, which conſtitute the difference of the ſexes.

One great objection to the theory delivered in the former part of this ſection on generation is removed by this idea of the exiſtence of formative fibrils, and formative molecules, which by their coaleſcence generate various parts of the embryon at the ſame time; which is, that in ſome monſtrous or imperfect fetuſes different parts only are produced, inſtead of the whole; and ſuch parts as would not appear to be primary ones. Such are the teeth and hair, which have been found in moles or falſe conceptions, as they exiſt naturally at a diſtance from the brain and heart, which are eſteemed to be the centre of vitality, and are firſt viſible in the embryon chick. Many other parts in monſtrous births are ſaid to have been completely formed, where no brain or heart has exiſted; the production of which on other ideas of generation cannot be explained; unleſs it be ſuppoſed, that an intire embryon had been at firſt generated, all of which had periſhed, and had been abſorbed, except the parts which conſtitute the monſtrous or imperfect fetus at its birth, which would be difficult to explain.

Many inſtances of very imperfect fetuſes are recorded by Monſ. J. J. Sue in his Rechearches ſur la Vitalité; and in the Comment. of Leipſic. I. 17. p. 528. M. Sue diſſected a fetus of five months old, which had no head, nor cheſt, nor ſtomach, nor large inteſtines, and yet the inferior half of the lower belly was complete, with the umbilical cord, male organs of generation, and one complete inferior limb, of which a print is given in Magazin. Encycloped. 1797. This monſtrous fetus, which was only half of it formed, ſhews, that the embryon is not always produced from one beginning, but probably from many: as there was no brain or heart, the connection of nerves in the lower part of the ſpine muſt have ſerved the purpoſe of the former; and a junction of the large arteries and veins muſt have ſerved the purpoſe of a heart, producing a circulation like that in the liver, or in the aorta and vena cava of fiſh. For a previous production and reabſorption of the other more eſſential parts of the fetus, as the brain and heart, with all the upper parts of the body, and inteſtines, would ſeem to be attended with ſtill greater difficulties.

This miſtake of conceiving the embryon to begin

gin its formation in one point only might more readily be fallen into from our habitually conſidering an animal as an individual entity; which it ſeems not to be, till an union of the nerves from every part is formed in the common ſenſorium, and produces a general ſenſibility, which is thus diſtinguiſhed from irritability, which may reſide in parts even when detached from the ſyſtem, as is ſeen in the contractions of the heart of a viper taken out of the body, or of limbs recently cut off.

2. Another thing difficult to conceive from thoſe theories, which ſuppoſed the firſt rudiment to conſiſt of a ſingle entity, was to anſwer the curious queſtion, whether the brain, or heart and arteries, were firſt formed; as the motions of the arterial ſyſtem previouſly exerted ſeem to have been neceſſary for the ſecretion of ſenſorial power in the brain, and converſely thoſe motions of the arterial ſyſtem ſeem previouſly to require the ſenſorial power derived from the brain.

This difficulty vaniſhes, when we believe, that many parts of the young embryon can be begun at the ſame time, as various formative fibrils and formative molecules coaleſce, as they come into contact with each other; and thus the rudiments of the brain and of the heart may be fabricated at the ſame inſtant of time.

3. If fibrils with formative appetencies, and molecules with formative aptitudes or propenſi-

ties exiſt in the circulation both of males and females, why do they not coaleſce there? This ſeems an unanſwerable objection to M. Buffon's theory, who holds, that organic particles exiſt in the circulation; but in the ſyſtem above delivered, no organic particles exiſt in the blood in their combined ſtate; and hence no microſcopic animalcula are ſeen in blood recently drawn, though they may appear after ſome hours ſtagnation; but the formative fibrils only and formative molecules are believed to exiſt in the circulation; and that they do not produce combinations there, as they cannot reſt; and as ſuch combinations would be too large to paſs the capillary veſſels of the aorta, and of the pulmonary artery, and of all the glands, and muſt there be perpetually diſſevered, if they could be previouſly formed in the larger veſſels.

4. If ſimilar organized particles were ſecreted by the ſexual glands of the male and alſo of the female, why do they not produce parts, or rudiments, of an embryon in the male or female reſervoirs without a reciprocal commixture. This is another unanſwerable objection to Mr. Buffon's theory, but not to that above delivered; which latter ſuppoſes, that no organized particles are ſecreted either by the glands of the male or female; but that the fibrils with formative appetencies are ſecreted by the glands of the male,

and the molecules with formative aptitudes or propenſities are ſecreted by thoſe of the female; and that, when theſe combine, the organization commences.

5. If the whole of the embryon is ſuppoſed to be ſynchronouſly produced, which is ſaid almoſt to be viſible in the cicatricula of the egg even before incubation, how can this happen from a commixture of any kind of particles deduced from both the male and female parents, if thoſe particles are previouſly detached from the various parts of their reſpective bodies; ſince no parts ſimilar to the female organs can previouſly exiſt in the male, nor any of thoſe of the male organs previouſly exiſt in the female? This ſynchronous production of all the parts of the embryon is ſuppoſed by M. Buffon, and militates againſt his theory; and if it was true, would equally militate againſt that above delivered; but from all the hiſtories of the beginning and growing fetus given by anatomiſts there are parts of ſecondary formation, as well as parts of primary formation; thus the head and ſpine of the back are firſt ſeen both in the oviparous and viviparous embryon, and afterwards the lungs, ribs, limbs, nails, hairs, and feathers, and laſt of all perhaps the glands which diſtinguiſh the ſexes; as theſe are the laſt, which afterwards arrive at their maturity.

This ſecondary formation of parts is evinced in the long caudexes of the buds of trees, which form a filament of the bark; as from any part of this a new plumula or leaf, which is the lungs of the embryon bud, can be produced, when the upper part of a branch is lopped off, as ſhewn in No. 9. 4. of this ſection; and is further evinced in ſome animals, as when a common earth-worm is cut in halves, the tail part can produce a head-part, and the head-part can produce a tail-part; and laſtly, it is evinced from the power, which crabs poſſeſs of generating a new leg, when one of them is accidentally broken off. This power is likewiſe poſſeſſed by the human body, as in the production of new teeth, and then of a ſecond ſet, and there are ſome inſtances on record, that a third ſet of teeth have been fabricated in the jaw-bones of age.

The power of formation of ſecondary parts in the human ſyſtem is wonderfully ſhewn by the following caſe, which is related by Mr. White in the Mancheſter Memoirs, Vol. I. p. 338. " Some years ago I delivered a lady of rank of a fine boy, who had two thumbs on one hand, or rather one thumb double from the firſt joint, the outer one being rather leſs than the inner, and each of them having a perfect nail. When he was about three years old, I was deſired to take off the leſſer one; which I did, but to my great aſtoniſhment it grew again, and along with it the nail. The family afterwards went to reſide in London, when the father ſhewed it to

Mr. Bromfield; who ſaid, that he ſuppoſed Mr. White, from fear of damaging the joint had not taken it wholly out, but that he would diſſect it out entirely, and that then it would not return. He accordingly executed his plan, and turned the ball out of the ſocket. Notwithſtanding this it grew again, a freſh nail was formed, and the thumb remains in this ſtate."

Recapitulation.

X. On conſidering the reproduction of vegetable buds and ſeeds, of ſome inſects, and of more perfect animals, the modes of generation may be divided into ſolitary and ſexual.

1. The firſt conſiſts either in ſolitary lateral generation, as in the reproduction of the buds or bulbs of vegetables, and of the young of the polypus, and of the hydra ſtentorea, or of the ſolitary internal generation, as of the aphis, vine-fretter, actinia, ſea-anemone, tenia, tape-worm, and the volvox; all which are properly a viviparous progeny, as they are not preceded by ſeeds, or ſpawn, or eggs.

In theſe modes of reproduction I ſuppoſe, that fibrils with formative appetencies, and molecules with formative aptitudes or propenſities, produced by, or detached from, various eſſential parts of their reſpective ſyſtems, float in the vegetable or inſect blood. Theſe may be termed animalized particles of primary combination, conſiſting of a ſolid particle adjoined to a peculiar appetency or propenſity; which latter may be eſteemed its ethereal part, as magnetiſm or electricity may be added to iron or to other inanimate bodies.

Theſe fibrils with formative appetencies, and molecules with formative aptitudes or propenſities, cannot unite, or continue united, in the circulating blood, as they are not at reſt; and would be too large to paſs the capillaries of the aorta, pulmonary artery, and glands, if they could be united in the larger veſſels: they are therefore ſelected or ſecreted ſeparately by adapted glands, and when mixed together combine, and form the primary parts of the new organization of an embryon.

Thoſe ſecreted from the long caudex of vegetable buds are depoſited beneath the cuticle of the bark of trees, and there uniting form a new caudex gemmæ along the ſide of the parent one; which has the property of producing ſecondary organizations from the new powers it has acquired, ſo as to form a leaf or lungs either at its ſummit in the axilla of the parent leaf, or in any other part of its length; and alſo to form radicles below, or from any amputated part.

This new caudex gemmæ is proved to commence its formation in ſeveral places at the ſame time from the triple caudex of the bud of a tree, which has been twice ſucceſſively ingrafted, which we have called a triple mule; but as the new vegetable conſiſts in general of a combination of parts derived from one parent, it much more accurately reſembles that parent in its form, growth, and diſeaſes, than the progeny from ſexual or ſeminal generation. The ſame circumſtances occur to the vegetables, which poſſeſs ſhort and flat caudexes, which exiſt between the radicles and the root-leaves, as in the bulbs of tulips and onions; which might poſſibly be ingrafted on each other like the buds of different trees, and form curious mule bulbs.

This lateral or ſolitary mode of propagation belongs likewiſe to the polypus of our ditches, and to the hydra ſtentorea, and probably to many other inſects.

2. There is alſo a ſolitary internal mode of generation, which occurs in the viviparous productions of the aphis, which are known to proceed for eight or nine ſucceſſive generations without the congreſs of ſexes; but what is extraordinary, a congreſs of ſexes appears to be neceſſary in their production of an oviparous progeny in the autumn for the preſervation of the ſpecies during winter; whence it would ſeem, that ſolitary generation always produces a viviparous offſpring. For the more particular hiſtory of this wonderful and important inſect ſee Phytologia, Sect. IX. and XIV. To which may be added, that a ſimilar internal ſolitary mode of repro-

duction probably obtains in the tenia, or tape-worm, of the inteſtines, which afflicts variety of animals, and of the actinea, or ſea-anemone, and of the volvox, as deſcribed in the Syſtema Naturæ of Linneus.

The eſſential difference between the ſolitary lateral generation and the ſolitary internal generation ſeems to conſiſt in this; that in the former there are many glands, which ſecrete or produce the fibrils with formative appetencies; and many other glands, which ſecrete or produce the molecules with formative aptitudes or propenſities; and that theſe numerous ſecretions are mixed together and combine in one large receptacle beneath the cuticle of trees, and of ſome inſects, and there combining generate the organized particles, which conſtitute the rudiment of the new embryon, producing many of the eſſential parts of it at the ſame time; whereas in the latter, there probably exiſts but one ſet of glands, which ſecrete the fibrils with formative appetencies; and another ſet of glands which ſecrete the molecules with formative propenſities; and that theſe primary particles are received and mingled together in a leſs extenſive reſervoir; as an univerſal exiſtence of procreative glands, as in the long caudexes of vegetable buds, might have been inconvenient to locomotive animals. Theſe therefore ſeem to conſtitute a link of the chain of nature between the lateral production of buds, and the ſexual hermaphrodites, which are next to be conſidered.

3. The ſexual mode of propagation may be divided firſt into hermaphrodite or reciprocal ſexual generation, as in the flowers of moſt vegetables, and in ſome large inſects, as in dew-worms and ſhell-ſnails, and probably in many ſmaller ones. Secondly into the ſimpler ſexual generation, which occurs in the larger animals.

The ſexual modes of generation may alſo be divided into the ſeminal or oviparous modes, as the ſeeds of plants, the ſpawn of fiſh, and of inſects, and the eggs of birds; and ſecondly into the viviparous modes, as the ſummit-bulbs of ſome vegetables, as of polygonum viviparum, magical onions, and the cloves of garlic; as theſe ſummit bulbs ſucceed the ſexual congreſs of the male and female organs of flowers; and are not buds, as their roots or caudexes do not paſs down the ſtem of the plant into the ground; and are therefore a ſexual viviparous progeny of vegetables: but the principal viviparous ſexual productions are thoſe of quadrupeds and of mankind.

Next to the internal ſolitary mode of propagation nature ſeems to have produced the hermaphrodite ſyſtem of reproduction, as in moſt flowers, and in ſnails and dew-worms; in theſe the maſculine and feminine organs are generally external and totally ſeparated from each other, and conſiſt of glands, which ſecrete the fibrils with formative appetencies, and the molecules with formative propenſities from the ſame maſs of blood.

Hence in vegetable productions the trees from ſeed, as apple trees, ſometimes exactly reſemble the parent tree, like the buds and bulbs, which are produced without ſexual intercourſe; at other times they do not exactly reſemble the parent tree, which ſeems to be owing to the anther-duſt ſometimes of the ſame flower, or ſometimes of other flowers in its vicinity, cauſing the impregnation of the ſtigma. But in hermaphrodite inſects, as the ſhell-ſnail, and dew-worm, I have frequently obſerved, that they impregnate each other reciprocally, though it is attended with much danger and inconvenience to them; and I thence conclude, that they have not the power to impregnate themſelves by the conjunction of their own organs of reproduction, ſince if that had happened, the progeny would probably, like the buds of trees, more exactly have reſembled the parent; and no improvement of the ſpecies, or no new ſpecies from the ſame genus, could have been procreated; which latter circumſtance has probably much increaſed the number both of animal and vegetable productions.

4. Laſtly, the ſimple mode of ſexual generation differs from the reciprocal or hermaphrodite

mode of generation; as the glands, which conſtitute the maſculine and feminine organs, ſecrete the fibrils with formative appetencies and the molecules with formative propenſities from different maſſes of blood; as a double ſyſtem of organs might have been cumberſome, if they had exiſted together in larger and more active animals: though it is not improbable, that all animals were originally hermaphrodite, according to the opinion of Plato in reſpect to human kind, as would appear from the teats or nipples, as well as the pectoral glands, which are ſtill to be ſeen in men and in all male quadrupeds.

In this mode of propagation the fibrils with formative appetencies detached from ſome or many eſſential parts of the male parent, or which were formed from the blood accordant to thoſe eſſential parts, are ſecreted by the male organ into an adapted reſervoir; and the molecules with formative propenſities detached from ſome or many eſſential parts of the female parent, or which are formed from the blood accordant to thoſe eſſential parts, are ſecreted by the female organ into an adapted reſervoir: and in this circumſtance ſecretion differs from nutrition; in the latter certain particles of the blood, which were not previouſly uſed in the ſyſtem, are embraced and become a ſolid part of the animal; in the former certain particles, which had previouſly been uſed in the ſyſtem, and detached from it, are imbibed by adapted glands, and depoſited in reſervoirs, or detruded. See Sect. XXXVII. 3.

Finally when theſe are mixed together in the act of copulation, they embrace and coaleſce, and form the eſſential parts of the new embryon; the production of which commences in more places than one; as the brain and heart, with ſome nerves, arteries, veins, and abſorbent veſſels, are probably formed at the ſame time, and almoſt inſtantaneouſly.

Theſe new fibrous combinations acquire new appetencies, and produce molecules by their vital activity with new aptitudes or propenſities; and thus gradually fabricate other ſecondary parts either ſynchronous or ſucceſſive ones, as the ribs, lungs, limbs, and finally the organs, which diſtinguiſh the ſexes, with the general difference of the male and female form throughout the whole ſyſtem, according to the prevailing or preponderant activity or quantity of the fibrils with appetencies derived from the male, or the molecules with propenſities derived from the female. This idea differs from the theory of M. Buffon, which ſuppoſes the whole embryon to be formed at the ſame time, or that the ſexual organs are firſt produced, as a centre of animalization; but the ſecondary production of theſe organs is agreeable to all obſervations on the growing chick or fetus, and is ſtrongly countenanced by the ſlow progreſs of theſe parts after birth, which are not complete till the maturity of the animal, which is termed its puberty.

The power, which the primary or eſſential parts of the embryon poſſeſs, of producing ſecondary or leſs eſſential parts, is analogous to the production of a new plumula or new radicles by the vegetable embryon, or caudex gemmæ mentioned in No. 8. 4. of this ſection; and to the power with which crabs are furniſhed to produce a new limb, when one is broken off; and to that of earth-worms, which when cut in halves, can acquire a new head or a new tail; and to the power in a human infant of regenerating a ſupernumerary thumb, to the production of a new ſet of teeth, and the developement of the ſexual glands at puberty. See No. 9. 5. of this ſection.

5. Some of theſe ſexual reproductions conſiſt of ſeeds, or eggs, in which the eſſential parts of the vegetable or of the chick are already formed, as may be ſeen in the corculum of many ſeeds, and in the cicatricula of an egg, as ſoon as it leaves the body of the hen before incubation. In this ſtate the embryon does not continue to grow, if expoſed only to the uſual degree of the warmth and moiſture of the atmoſphere, but may be long kept in its ſtate of inſenſible life; though it will ſoon ferment or putreſy, if it be deprived of life.

Otherwiſe theſe ſexual productions conſiſt of ſpawn, which differs from eggs by the embryon not being included in a hard unyielding ſhell; ſo that the receptacle diſtends, as the fetus increaſes in ſize; which is ſeen in the ſpawn of fiſh and frogs, and in the eggs of ſpiders, ſnails, and many other inſects. From this diſtenſibility of the bag, which contains the embryons of fiſh and inſects, it ſeems more to reſemble the uterus of quadrupeds than the eggs of birds; as in the former the receptacle increaſes in ſize along with the fetus, and ſupplies the liquor of the amnios, as it is wanted; but differs by its not continuing in the matrix of the mother, till the excluſion of the young animal into the cold and dry atmoſphere.

XI. 1. Finally we conclude, that as the inanimate particles or atoms of matter unite into cryſtals of various forms by the various powers of attraction, which ſome kinds of them poſſeſs; and the various aptitudes to be attracted, which other kinds poſſeſs; which may be termed the ethereal properties of inanimate matter; ſo the animated fibrils or molecules, which poſſeſs appetencies to embrace, and propenſities to be embraced, which may be called their ethereal properties, coaleſce, when they approach each other, and form organized bodies.

When this organization begins only in a ſingle point, and only enlarges, as it acquires new kinds of appetencies, as explained in the former part of this ſection on Generation, I ſuppoſe an animated being commences; ſuch as the animalcula, which are ſeen by the ſolar microſcope in variety of fluids, which have for a time ſtagnated; as in infuſions of the ſeeds of plants, in the ſemen of animals, and of all other vegetable and animal recrements diffuſed in water. Theſe microſcopic animals I ſuppoſe are produced by the ſtagnation of the ſemen in the veſiculæ ſeminales, and by the matter of the itch by ſtagnation in its puſtules, and by the feces by their ſtagnation in the inteſtines; but I believe, that they do not exiſt in the blood, nor in fluids recently ſecreted. Theſe microſcopic animals conſtitute the primordium vitæ, or firſt order of animal life, and probably are not originally propagated, but ſimply ariſe from the diſſolution of all vegetable or animal matter.

This ſpontaneous production of microſcopic animals appears from their being diſcovered in a few days in all ſolutions of decompoſing vegetable and animal matters, as well after having been ſubjected to the heat of boiling water as before. Thus Mr. Reaumur put ſome boiling veal broth, and Mr. Baker put ſome boiling hot maſhed potatoes into hot phials, which were cloſed with glaſs-ſtopples; and both of them in three days became as full of animalcula, as the ſame materials put into other phials without being previouſly boiled. Baker on the Microſcope.

It it probable that there exiſt microſcopic vegetable productions, as well as microſcopic animals, which may not have been attended to owing to the quick evaporation of a drop of water in a microſcope; and that theſe are firſt formed ſpontaneouſly from the decompoſing recrements of vegetable or animal bodies; and that they afterwards generate others rather more perfect than themſelves by lateral reproduction. From this kind of ſpontaneous microſcopic vegetation, I ſuppoſe the green matter obſerved by Dr. Prieſtley, which gives up ſo much vital air in the ſunſhine, originates; and that it afterwards generates a ſucceeding progeny. As it is at firſt ſlowly produced in water in any ſituation, and afterwards is propagated with great rapidity; and according to the obſervations of Senebier it is moſt quickly produced in water in which vegetable or animal ſubſtances are in a ſtate of diſſolution. Whence ſome philoſophers have lately ſuppoſed this green matter to be of animal origin, as it changes from a globular form to that of a thread; which has occaſioned much inveſtigation by Fontana, Ingenhouz, and Senebier. Journal de Phyſique par Delametherie, T. 5.

In the ſame manner the mucor, or mould, which grows on all decompoſing vegetable and animal ſubſtances, which are at reſt in a proper degree of moiſture and warmth, and which thence appears to have no parent, is probably firſt produced by the ſpontaneous appetencies and aptitudes or propenſities of the decompoſed particles of organic bodies; and probably theſe new combinations are at firſt microſcopic objects, which produce others by lateral or ſolitary generation, more and more perfect and of greater magnitude than themſelves, but which never acquire the organization neceſſary for ſexual reproduction. The fungi, which grow only on decaying parts of trees or other vegetables, as well as the muſhrooms from horſe dung, which commence with ſmall hair-like roots, and probably never produce ſeeds, ſeem to ariſe in a ſimilar manner from ſpontaneous microſcopic organization, improved and magnified by ſucceſſive ſolitary generations.

2. The ſecond kind of animal production, which is properly generation, commences in more points than one; as in the production of the long caudexes of the buds of trees; and the animated fibrils and molecules firſt combine, and form organized bodies; and theſe unite again, where they are in contact; and thus the new embryon commences in many points at once; and the ſolitary mode of generation is ſecondary to the production of the ſmalleſt microſcopic animals, which I ſuppoſe commence their exiſtence in one point only, that is, by the production firſt of a ſingle living filament, which I formerly believed to be the general mode of propagation. This ſolitary mode of generation occurs in the

production of the buds of all vegetables; and perhaps the moſt imperfect vegetables, as truffles, and other fungi, are only propagated by buds to this day, not having yet acquired ſexual organs; as ſeems alſo to occur in ſome imperfect animals, as the polypi, hydra, and tenia.

3. Other vegetables have acquired an hermaphrodite ſtate, and poſſeſs external ſexual organs, as in moſt flowers; but both the male and female organs acquire or produce their adapted fluids from the ſame maſs of blood, and thus reſemble hermaphrodite inſects, as ſnails and worms.

4. Other vegetables have acquired a ſeparation of the ſexes, either on the ſame plant, as in the claſs of vegetables termed by Linneus, monoecia, or on different plants, as in the claſs dioecia; the buds of which may properly be called male or female vegetables, and differ in ſome degree in their form and colour, like male and female animals; and in this they reſemble the larger animals, as their ſexual glands acquire or produce their prolific fluids from different maſſes of blood; which is probably leſs cumberſome to the individual, than where both the ſexual glands exiſt in one organized ſyſtem.

In all theſe vegetable and animal modes of reproduction, I ſuppoſe the new embryon to begin in many points, and in complicated animals in many more points probably than in the more ſimple ones; and finally, that as theſe new organized parts, or rudiments of the embryon, acquire new appetencies, and produce or find molecules with new propenſities, many ſecondary parts are afterwards fabricated.

Thus it would appear, that all nature exiſts in a ſtate of perpetual improvement by laws impreſſed on the atoms of matter by the great CAUSE OF CAUSES; and that the world may ſtill be in its infancy, and continue to improve FOR EVER AND EVER.

5. Concerning the ſpontaneous production of microſcopic animalcules, I beg leave to repeat, firſt, that I ſuppoſe the ſmalleſt ones to be formed by the coaleſcence or embrace of the animal fibrils, which poſſeſs appetencies, with the animal molecules, which poſſeſs correſpondent propenſities; and that the animal fibrils and molecules are found in all vegetable and animal matter, as its organization becomes decompoſed; if there exiſts along with it ſufficient moiſture and proper warmth.

Secondly, that this kind of ſpontaneous reproduction reſembles actual generation in its conſiſting of the coaleſcence of animal fibrils with appetencies and animal molecules with correſpondent propenſities, that in the former they meet each other in the ſolution of animal matter, as it decompoſes by ſtagnation; whereas in the latter theſe formative fibrils and molecules are ſecreted by different glands from the blood of the parent.

Thirdly, that the firſt animalcules produce other ones by actual generation, but without ſexes, like the buds of trees, and that as many generations may occur in a day, perhaps in an hour, I conceive, that they may gradually acquire new organizations, and improve by addition of new parts, as of fins, mouth, inteſtines, and finally, perhaps, ſexual organs of reproduction. Thus the ſeed of a tulip produces a ſmall root the ſize of a pea the firſt ſummer, with a ſummit like a blade of graſs; this dies in autumn, having previouſly produced a ſucceſſor larger than itſelf, and with a ſtronger leaf or ſummit; in the autumn this likewiſe periſhes, and a third generation is produced, which is ſtill larger and more perfect; till the fifth generation from the ſeed becomes ſo much more perfect as to produce ſexual organs of reproduction, as the flower with its anthers and ſtigma.

This curious analogy is not only ſupported by the ſeedling buds of trees, which ſucceed each other for ten or twelve generations, the parent buds dying in the autumn, before they become ſufficiently perfect to form the ſexual organs of reproduction in their flowers, as occurs in apple-trees; but is alſo obſervable in a complete inſect, as in the aphis, which continues to propagate for nine generations from the egg without ſex; and then becomes ſo perfect as to form ſexual organs, and to produce an oviparous progeny.

Other inſects, as the moths and butterflies, undergo a great change of form, before they acquire the property of ſexual reproduction; and probably innumerable other kinds of inſects are ſubject to the ſame law.

This idea of the production and changes of form of microſcopic animalcules is countenanced by the ſmaller kinds never, I believe, having been ſeen in their egg or infant ſtate; and by ſome of them being capable of being revived in a few hours by warmth and moiſture after having been dry and motionleſs for months, as the inſect named vorticella. And laſtly, from the changeful forms, which ſome of them aſſume, as that which is called proteus. See Baker and Adams on the Microſcope.

Thus as by the attractions, and aptitudes to be attracted, which exiſt in inanimate matter, various new bodies are produced from the decompoſition of thoſe, which previouſly exiſted; ſo by the appetencies to embrace, and the propenſities to be embraced, in animalized matter, various new animalcules are formed from the decompoſition of thoſe, which previouſly exiſted; owing in both caſes to the immutable laws impreſſed both on inanimate and on organized matter by the great FIRST CAUSE.

XII. 1. CAUSE AND EFFECT may be conſidered as the progreſſion, or ſucceſſive motions, of the parts of the great ſyſtem of Nature. The ſtate of things at this moment is the effect of the ſtate of things, which exiſted in the preceding moment; and the cauſe of the ſtate of things, which ſhall exiſt in the next moment.

Theſe cauſes and effects may be more eaſily comprehended, if motion be conſidered as a change of the figure of a group of bodies, as propoſed in Sect. XIV. 2. 2. inaſmuch as our ideas of viſible or tangible objects are more diſtinct, than our abſtracted ideas of their motions. Now the change of the configuration of the ſyſtem of nature at this moment muſt be an effect of the preceding configuration, for a change of configuration cannot exiſt without a previous configuration; and the proximate cauſe of every effect muſt immediately precede that effect. For example, a moving ivory ball could not proceed onwards, unleſs it had previouſly begun to proceed; or unleſs an impulſe had been previouſly given it; which previous motion or impulſe conſtitutes a part of the laſt ſituation of things.

As the effects produced in this moment of time become cauſes in the next, we may conſider the progreſſive motions of objects as a chain of cauſes only; whoſe firſt link proceeded from the great Creator, and which have exiſted from the beginning of the created univerſe, and are perpetually proceeding.

2. Theſe cauſes may be conveniently divided into two kinds, efficient and inert cauſes, accord-

ing with the two kinds of entity ſuppoſed to exiſt in the natural world, which may be termed matter and ſpirit, as propoſed in Sect. I. and further treated of in Sect. XIV. The efficient cauſes of motion, or new configuration, conſiſt either of the principle of general gravitation, which actuates the ſun and planets; or of the principle of particular gravitation, as in electricity, magnetiſm, heat; or of the principle of chemical affinity, as in combuſtion, fermentation, combination; or of the principle of organic life, as in the contraction of vegetable and animal fibres. The inert cauſes of motion, or new configuration, conſiſt of the parts of matter, which are introduced within the ſpheres of activity of the principles above deſcribed. Thus, when an apple falls on the ground, the principle of gravitation is the efficient cauſe, and the matter of the apple-tree the inert cauſe. If a bar of iron be approximated to a magnet, it may be termed the inert cauſe of the motion, which brings theſe two bodies into contact; while the magnetic principle may be termed the efficient cauſe. In the ſame manner the fibres, which conſtitute the retina, may be called the inert cauſe of the motions of that organ in viſion, while the ſenſorial power may be termed the efficient cauſe.

3. Another more common diſtribution of the perpetual chain of cauſes and effects, which conſtitute the motions, or changing configurations,

of the natural world, is into active and paſſive. Thus, if a ball in motion impinges againſt another ball at reſt, and communicates its motion to it, the former ball is ſaid to act, and the latter to be acted upon. In this ſenſe of the words a magnet is ſaid to attract iron; and the prick of a ſpur to ſtimulate a horſe into exertion; ſo that in this view of the works of nature all things may be ſaid either ſimply to exiſt, or to exiſt as cauſes, or to exiſt as effects; that is, to exiſt either in an active or paſſive ſtate.

This diſtribution of objects, and their motions, or changes of poſition, has been found ſo convenient for the purpoſes of common life, that on this foundation reſts the whole conſtruction or theory of language. The names of the things themſelves are termed by grammarians Nouns, and their modes of exiſtence are termed Verbs. The nouns are divided into ſubſtantives, which denote the principal things ſpoken of; and into adjectives, which denote ſome circumſtances, or leſs kinds of things, belonging to the former. The verbs are divided into three kinds, ſuch as denote the exiſtence of things ſimply, as, to be; or their exiſtence in an active ſtate, as, to eat; or their exiſtence in a paſſive ſtate, as, to be eaten. Whence it appears, that all languages conſiſt only of nouns and verbs, with their abbreviations for the greater expedition of communicating our thoughts; as explained in the ingenious work of Mr. Horne Tooke, who has unfolded by a ſingle flaſh of light the whole theory of language, which had ſo long lain buried beneath the learned lumber of the ſchools. Diverſions of Purley. Johnſon. London.

4. A third diviſion of cauſes has been into proximate and remote; theſe have been much ſpoken of by the writers on medical ſubjects, but without ſufficient preciſion. If to proximate and remote cauſes we add proximate and remote effects, we ſhall include four links of the perpetual chain of cauſation; which will be more convenient for the diſcuſſion of many philoſophical ſubjects.

Thus if a particle of chyle be applied to the mouth of a lacteal veſſel, it may be termed the remote cauſe of the motions of the fibres, which compoſe the mouth of that lacteal veſſel; the ſenſorial power is the proximate cauſe; the contraction of the fibres of the mouth of the veſſel is the proximate effect; and their embracing the particle of chyle is the remote effect; and theſe four links of cauſation conſtitute abſorption.

Thus when we attend to the riſing ſun, firſt the yellow rays of light ſtimulate the ſenſorial power reſiding in the extremities of the optic nerve, this is the remote cauſe. 2. The ſenſorial power is excited into a ſtate of activity, this is the proximate cauſe. 3. The fibrous extremities of the optic nerve are contracted, this is the proximate effect. 4. A pleaſurable or painful ſenſation

tion is produced in conſequence of the contraction of theſe fibres of the optic nerve, this is the remote effect; and theſe four links of the chain of cauſation conſtitute the ſenſitive idea, or what is commonly termed the ſenſation of the riſing ſun.

5. Other cauſes have been announced by medical writers under the names of cauſa procatarctica, and cauſa proegumina, and cauſa ſine quâ non. All which are links more or leſs diſtant of the chain of remote cauſes.

To theſe muſt be added the final cauſe, ſo called by many authors, which means the motive, for the accompliſhment of which the preceding chain of cauſes was put into action. The idea of a final cauſe, therefore, includes that of a rational mind, which employs means to effect its purpoſes; thus the deſire of preſerving himſelf from the pain of cold, which he has frequently experienced, induces the ſavage to conſtruct his hut; the fixing ſtakes into the ground for walls, branches of trees for rafters, and turf for a cover, are a ſeries of ſucceſſive voluntary exertions; which are ſo many means to produce a certain effect. This effect of preſerving himſelf from cold, is termed the final cauſe; the conſtruction of the hut is the remote effect; the action of the muſcular fibres of the man, is the proximate effect; the volition, or activity of deſire to preſerve himſelf from cold, is the proximate cauſe; and the pain of cold, which excited that deſire, is the remote cauſe.

6. This

6. This perpetual chain of cauſes and effects, the firſt link of which is rivetted to the throne of God; divides itſelf into innumerable diverging branches, which, like the nerves ariſing from the brain, permeate the moſt minute and moſt remote extremities of the ſyſtem, diffuſing motion and ſenſation to the whole. As every cauſe is ſuperior in power to the effect, which it has produced, ſo our idea of the power of the Almighty Creator becomes more elevated and ſublime, as we trace the operations of nature from cauſe to cauſe, climbing up the links of theſe chains of being, till we aſcend to the Great Source of all things.

Hence the modern diſcoveries in chemiſtry and in geology, by having traced the cauſes of the combinations of bodies to remoter origins, as well as thoſe in aſtronomy, which dignify the preſent age, contribute to enlarge and amplify our ideas of the power of the Great Firſt Cauſe. And had thoſe ancient philoſophers, who contended that the world was formed from atoms, aſcribed their combinations to certain immutable properties received from the hand of the Creator, ſuch as general gravitation, chemical affinity, or animal appetency, inſtead of aſcribing them to a blind chance; the doctrine of atoms, as conſtituting or compoſing the material world by the variety of their combinations, ſo far from leading the mind to atheiſm, would ſtrengthen the demonſtration of the exiſtence of a Deity, as the firſt cauſe of all things; becauſe the analogy reſulting from our perpetual experience of cauſe and effect would have thus been exemplified through univerſal nature.

The heavens declare the Glory of God, *and the firmament ſheweth his handywork! One day telleth another, and one night certifieth another; they have neither ſpeech nor language, yet their voice is gone forth into all lands, and their words into the ends of the world. Manifold are thy works,* O Lord! *in wiſdom haſt thou made them all.* Pſal. xix. civ.

SECT. XL.

On the OCULAR SPECTRA of Light and Colours, by Dr. R. W. Darwin, of Shrewſbury. Reprinted, by permiſſion, from the Philoſophical Tranſactions, Vol. LXXVI. p. 313.

Spectra of four kinds. 1. *Activity of the retina in viſion.* 2. *Spectra from defect of ſenſibility.* 3. *Spectra from exceſs of ſenſibility.* 4. *Of direct ocular ſpectra.* 5. *Greater ſtimulus excites the retina into ſpaſmodic action.* 6. *Of reverſe ocular ſpectra.* 7. *Greater ſtimulus excites the retina into various ſucceſſive ſpaſmodic actions.* 8. *Into fixed ſpaſmodic action.* 9. *Into temporary paralyſis.* 10. *Miſcellaneous remarks*; 1. *Direct and reverſe ſpectra at the ſame time. A ſpectral halo. Rule to predetermine the colours of ſpectra.* 2. *Variation of ſpectra from extraneous light.* 3. *Variation of ſpectra in number, figure, and remiſſion.* 4. *Circulation of the blood in the eye is viſible.* 5. *A new way of magnifying objects. Concluſion.*

WHEN any one has long and attentively looked at a bright object, as at the ſetting ſun, on cloſing his eyes, or removing them, an image, which reſembles in form the object he was attending to, continues ſome time to be viſible; this appearance in the eye we ſhall call the ocular ſpectrum of that object.

Theſe ocular ſpectra are of four kinds: 1ſt, Such as are owing to a leſs ſenſibility of a defined part of the retina; or *ſpectra from defect of ſenſibility*. 2d, Such as are owing to a greater ſenſibility of a defined part of the retina; or *ſpectra from exceſs of ſenſibility*. 3d, Such as reſemble their object in its colour as well as form; which may be termed *direct ocular ſpectra*. 4th, Such as are of a colour contrary to that of their object; which may be termed *reverſe ocular ſpectra*.

The laws of light have been moſt ſucceſsfully explained by the great Newton, and the perception of viſible objects has been ably inveſtigated by the ingenious Dr. Berkeley and M. Malebranche; but theſe minute phænomena of viſion have yet been thought reducible to no theory, though many philoſophers have employed a conſiderable degree of attention upon them: among theſe are Dr. Jurin, at the end of Dr. Smith's Optics; M. Æpinus, in the Nov. Com. Petropol. V. 10.; M. Beguelin, in the Berlin Mémoires, V. II. 1771; M. d'Arcy, in the Hiſtoire de l'Acad. des Scienc. 1765; M. de la Hire; and, laſtly, the celebrated M. de Buffon, in the Mémoires de l'Acad. des Scien. who has termed them accidental colours, as if ſubjected to no eſtabliſhed laws, Ac. Par. 1743. M. p. 215.

I muſt here apprize the reader, that it is very difficult for different people to give the ſame names to various ſhades of colours; whence, in the following pages, ſomething muſt be allowed, if on repeating the experiments the colours here mentioned ſhould not accurately correſpond with his own names of them.

I. *Activity of the Retina in Viſion.*

From the ſubſequent experiments it appears, that the retina is in an active not in a paſſive ſtate during the exiſtence of theſe ocular ſpectra; and it is thence to be concluded, that all viſion is owing to the activity of this organ.

1. Place a piece of red ſilk, about an inch in diameter, as in plate 1, at Sect. III. 1, on a ſheet of white paper, in a ſtrong light; look ſteadily upon it from about the diſtance of half a yard for a minute; then cloſing your eyelids cover them with your hands, and a green ſpectrum will be ſeen in your eyes, reſembling in form the piece of red ſilk: after ſome time, this ſpectrum will diſappear and ſhortly reappear; and this alternately three or four times, if the experiment is well made, till at length it vaniſhes entirely.

2. Place on a ſheet of white paper a circular piece of blue ſilk, about four inches in diameter, in the ſunſhine; cover the centre of this with a circular piece of yellow ſilk, about three inches in diameter; and the centre of the yellow ſilk with a circle of pink ſilk, about two inches in

diameter; and the centre of the pink ſilk with a circle of green ſilk, about one inch in diameter; and the centre of this with a circle of indigo, about half an inch in diameter; make a ſmall ſpeck with ink in the very centre of the whole, as in plate 3, at Sect. III. 3. 6.; look ſteadily for a minute on this central ſpot, and then cloſing your eyes, and applying your hand at about an inch diſtance before them, ſo as to prevent too much or too little light from paſſing through the eyelids, you will ſee the moſt beautiful circles of colours that imagination can conceive, which are moſt reſembled by the colours occaſioned by pouring a drop or two of oil on a ſtill lake in a bright day; but theſe circular iriſes of colours are not only different from the colours of the ſilks above mentioned, but are at the ſame time perpetually changing as long as they exiſt.

3. When any one in the dark preſſes either corner of his eye with his finger, and turns his eye away from his finger, he will ſee a circle of colours like thoſe in a peacock's tail: and a ſudden flaſh of light is excited in the eye by a ſtroke on it. (Newton's Opt. Q. 16.)

4. When any one turns round rapidly on one foot, till he becomes dizzy, and falls upon the ground, the ſpectra of the ambient objects continue to preſent themſelves in rotation, or appear to librate, and he ſeems to behold them for ſome time ſtill in motion.

From all theſe experiments it appears, that the ſpectra in the eye are not owing to the mechanical impulſe of light impreſſed on the retina, nor to its chemical combination with that organ, nor to the abſorption and emiſſion of light, as is obſerved in many bodies; for in all theſe caſes the ſpectra muſt either remain uniformly, or gradually diminiſh; and neither their alternate preſence and evaneſcence as in the firſt experiment, nor the perpetual changes of their colours as in the ſecond, nor the flaſh of light or colours in the preſſed eye as in the third, nor the rotation or libration of the ſpectra as in the fourth, could exiſt.

It is not abſurd to conceive, that the retina may be ſtimulated into motion, as well as the red and white muſcles which form our limbs and veſſels; ſince it conſiſts of fibres, like thoſe, intermixed with its medullary ſubſtance. To evince this ſtructure, the retina of an ox's eye was ſuſpended in a glaſs of warm water, and forcibly torn in a few places; the edges of theſe parts appeared jagged and hairy, and did not contract, and become ſmooth like ſimple mucus, when it is diſtended till it breaks; which ſhews that it conſiſts of fibres: and its fibrous conſtruction became ſtill more diſtinct to the ſight, by adding ſome cauſtic alkali to the water, as the adhering mucus was firſt eroded, and the hair-like fibres remained floating in the veſſel. Nor does the degree of tranſparency of the retina invalidate the evidence of its fibrous ſtructure, ſince Leeuwenhoek has ſhewn that the cryſtalline humour itſelf conſiſts of fibres. (Arcana Naturæ, Vol. I. p. 70.)

Hence it appears, that as the muſcles have larger fibres intermixed with a ſmaller quantity of nervous medulla, the organ of viſion has a greater quantity of nervous medulla intermixed with ſmaller fibres; and it is probable that the locomotive muſcles, as well as the vaſcular ones, of microſcopic animals have much greater tenuity than theſe of the retina.

And beſides the ſimilar laws, which will be ſhewn in this paper to govern alike the actions of the retina and of the muſcles, there are many other analogies which exiſt between them. They are both originally excited into action by irritations, both act nearly in the ſame quantity of time, are alike ſtrengthened or fatigued by exertion, are alike painful if excited into action when they are in an inflamed ſtate, are alike liable to paralyſis, and to the torpor of old age.

II. Of spectra from defect of sensibility.

The retina is not ſo eaſily excited into action by leſs irritation after having been lately ſubjected to greater.

1. When any one paſſes from the bright daylight

light into a darkened room, the iriſes of his eyes expand themſelves to their utmoſt extent in a few ſeconds of time; but it is very long before the optic nerve, after having been ſtimulated by the greater light of the day, becomes ſenſible of the leſs degree of it in the room; and, if the room is not too obſcure, the iriſes will again contract themſelves in ſome degree, as the ſenſibility of the retina returns.

2. Place about half an inch ſquare of white paper on a black hat, and looking ſteadily on the centre of it for a minute, remove your eyes to a ſheet of white paper; and after a ſecond or two a dark ſquare will be ſeen on the white paper, which will continue ſome time. A ſimilar dark ſquare will be ſeen in the cloſed eye, if light be admitted through the eyelids.

So after looking at any luminous object of a ſmall ſize, as at the ſun, for a ſhort time, ſo as not much to fatigue the eyes, this part of the retina becomes leſs ſenſible to ſmaller quantities of light; hence, when the eyes are turned on other leſs luminous parts of the ſky, a dark ſpot is ſeen reſembling the ſhape of the ſun, or other luminous object which we laſt beheld. This is the ſource of one kind of the dark-coloured *muſcæ volitantes*. If this dark ſpot lies above the centre of the eye, we turn our eyes that way, expecting to bring it into the centre of the eye, that we may view it more diſtinctly; and in this caſe the dark ſpectrum ſeems to move upwards. If the dark ſpectrum is found beneath the centre of the eye, we purſue it from the ſame motive, and it ſeems to move downwards. This has given riſe to various conjectures of ſomething floating in the aqueous humours of the eyes; but whoever, in attending to theſe ſpots, keeps his eyes unmoved by looking ſteadily at the corner of a cloud, at the ſame time that he obſerves the dark ſpectra, will be thoroughly convinced, that they have no motion but what is given to them by the movement of our eyes in purſuit of them. Sometimes the form of the ſpectrum, when it has been received from a circular luminous body, will become oblong; and ſometimes it will be divided into two circular ſpectra, which is not owing to our changing the angle made by the two optie axiſes, according to the diſtance of the clouds or other bodies to which the ſpectrum is ſuppoſed to be contiguous, but to other cauſes mentioned in No. X. 3. of this ſection. The apparent ſize of it will alſo be variable according to its ſuppoſed diſtance.

As theſe ſpectra are more eaſily obſervable when our eyes are a little weakened by fatigue, it has frequently happened, that people of delicate conſtitutions have been much alarmed at them, fearing a beginning decay of their ſight, and have thence fallen into the hands of ignorant oculiſts; but I believe they never are a prelude to any other diſeaſe of the eye, and that it is from habit alone, and our want of attention to them, that we do not ſee them on all objects every hour of our lives. But as the nerves of very weak people loſe their ſenſibility, in the ſame manner as their muſcles loſe their activity, by a ſmall time of exertion, it frequently happens, that ſick people in the extreme debility of fevers are perpetually employed in picking ſomething from the bed-clothes, occaſioned by their miſtaking the appearance of theſe *muſcæ volitantes* in their eyes. Benvenuto Celini, an Italian artiſt, a man of ſtrong abilities, relates, that having paſſed the whole night on a diſtant mountain with ſome companions and a conjurer, and performed many ceremonies to raiſe the devil, on their return in the morning to Rome, and looking up when the ſun began to riſe, they ſaw numerous devils run on the tops of the houſes, as they paſſed along; ſo much were the ſpectra of their weakened eyes magnified by fear, and made ſubſervient to the purpoſes of fraud or ſuperſtition. (Life of Ben. Celini.)

3. Place a ſquare inch of white paper on a large piece of ſtraw-coloured ſilk; look ſteadily ſome time on the white paper, and then move the centre of your eyes on the ſilk, and a ſpectrum of the form of the paper will appear on the ſilk, of a deeper yellow than the other part of it: for the central part of the retina, having been ſome time expoſed to the ſtimulus of a greater quantity of white

light, is become leſs ſenſible to a ſmaller quantity of it, and therefore ſees only the yellow rays in that part of the ſtraw-coloured ſilk.

Facts ſimilar to theſe are obſervable in other parts of our ſyſtem: thus, if one hand be made warm, and the other expoſed to the cold, and then both of them immerſed in ſubtepid water, the water is perceived warm to one hand, and cold to the other; and we are not able to hear weak ſounds for ſome time after we have been expoſed to loud ones; and we feel a chillineſs on coming into an atmoſphere of temperate warmth, after having been ſome time confined in a very warm room: and hence the ſtomach, and other organs of digeſtion, of thoſe who have been habituated to the greater ſtimulus of ſpirituous liquor, are not excited into their due action by the leſs ſtimulus of common food alone; of which the immediate conſequence is indigeſtion and hypochondriaciſm.

III. OF SPECTRA FROM EXCESS OF SENSIBILITY.

The retina is more eaſily excited into action by greater irritation after having been lately ſubjected to leſs.

1. If the eyes are cloſed, and covered perfectly with a hat, for a minute or two, in a bright day;

on removing the hat a red or crimſon light is ſeen through the eyelids. In this experiment the retina, after being ſome time kept in the dark, becomes ſo ſenſible to a ſmall quantity of light, as to perceive diſtinctly the greater quantity of red rays than of others which paſs through the eyelids. A ſimilar coloured light is ſeen to paſs through the edges of the fingers, when the open hand is oppoſed to the flame of a candle.

2. If you look for ſome minutes ſteadily on a window in the beginning of the evening twilight, or in a dark day, and then move your eyes a little, ſo that thoſe parts of the retina, on which the dark frame-work of the window was delineated, may now fall on the glaſs part of it, many luminous lines, repreſenting the frame-work, will appear to lie acroſs the glaſs panes: for thoſe parts of the retina, which were before leaſt ſtimulated by the dark frame-work, are now more ſenſible to light than the other parts of the retina which were expoſed to the more luminous parts of the window.

3. Make with ink on white paper a very black ſpot, about half an inch in diameter, with a tail about an inch in length, ſo as to repreſent a tadpole, as in plate 2, at Sect. III. 8. 3.; look ſteadily for a minute on this ſpot, and, on moving the eye a little, the figure of the tadpole will be ſeen on the white part of the paper, which figure of the tadpole will appear whiter or more

luminous than the other parts of the white paper; for the part of the retina on which the tadpole was delineated, is now more ſenſible to light than the other parts of it, which were expoſed to the white paper. This experiment is mentioned by Dr. Irwin, but is not by him aſcribed to the true cauſe, namely, the greater ſenſibility of that part of the retina which has been expoſed to the black ſpot, than of the other parts which had received the white field of paper, which is put beyond a doubt by the next experiment.

4. On cloſing the eyes after viewing the black ſpot on the white paper, as in the foregoing experiment, a red ſpot is ſeen of the form of the black ſpot: for that part of the retina, on which the black ſpot was delineated, being now more ſenſible to light than the other parts of it, which were expoſed to the white paper, is capable of perceiving the red rays which penetrate the eyelids. If this experiment be made by the light of a tallow candle, the ſpot will be yellow inſtead of red; for tallow candles abound much with yellow light, which paſſes in greater quantity and force through the eyelids than blue light; hence the difficulty of diſtinguiſhing blue and green by this kind of candle light. The colour of the ſpectrum may poſſibly vary in the daylight, according to the different colour of the meridian or the morning or evening light.

M. Beguelin, in the Berlin Mémoires, V. II.

1771, obſerves, that, when he held a book ſo that the ſun ſhone upon his half-cloſed eyelids, the black letters, which he had long inſpected, became red, which muſt have been thus occaſioned. Thoſe parts of the retina which had received for ſome time the black letters, were ſo much more ſenſible than thoſe parts which had been oppoſed to the white paper, that to the former the red light, which paſſed through the eyelids, was perceptible. There is a ſimilar ſtory told, I think, in M. de Voltaire's Hiſtorical Works, of a Duke of Tuſcany, who was playing at dice with the general of a foreign army, and, believing he ſaw bloody ſpots upon the dice, portended dreadful events, and retired in confuſion. The obſerver, after looking for a minute on the black ſpots of a die, and careleſsly cloſing his eyes, on a bright day, would ſee the image of a die with red ſpots upon it, as above explained.

5. On emerging from a dark cavern, where we have long continued, the light of a bright day becomes intolerable to the eye for a conſiderable time, owing to the exceſs of ſenſibility exiſting in the eye, after having been long expoſed to little or no ſtimulus. This occaſions us immediately to contract the iris to its ſmalleſt aperture, which becomes again gradually dilated, as the retina becomes accuſtomed to the greater ſtimulus of the daylight.

The twinkling of a bright ſtar, or of a diſtant candle in the night, is perhaps owing to the ſame cauſe. While we continue to look upon theſe luminous objects, their central parts gradually appear paler, owing to the decreaſing ſenſibility of the part of the retina expoſed to their light; whilſt, at the ſame time, by the unſteadineſs of the eye, the edges of them are perpetually falling on parts of the retina that were juſt before expoſed to the darkneſs of the night, and therefore tenfold more ſenſible to light than the part on which the ſtar or candle had been for ſome time delineated. This pains the eye in a ſimilar manner as when we come ſuddenly from a dark room into bright day-light, and gives the appearance of bright ſcintillations. Hence the ſtars twinkle moſt when the night is darkeſt, and do not twinkle through teleſcopes, as obſerved by Muſchenbroeck; and it will afterwards be ſeen why this twinkling is ſometimes of different colours when the object is very bright, as Mr. Melvill obſerved in looking at Sirius. For the opinions of others on this ſubject, ſee Dr. Prieſtley's valuable Hiſtory of Light and Colours, p. 494.

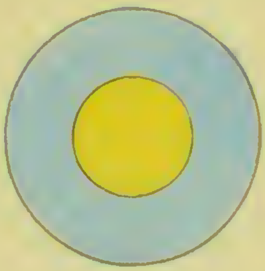
Many facts obſervable in the animal ſyſtem are ſimilar to theſe; as the hot glow occaſioned by the uſual warmth of the air, or our clothes, on coming out of a cold bath; the pain of the fingers on approaching the fire after having handled ſnow; and the inflamed heels from walking in ſnow. Hence thoſe who have been expoſed to much cold have died on being brought to a fire, or their limbs have become ſo much inflamed as to mortify. Hence much food or wine given ſuddenly to thoſe who have almoſt periſhed by hunger has deſtroyed them; for all the organs of the famiſhed body are now become ſo much more irritable to the ſtimulus of food and wine, which they have long been deprived of, that inflammation is excited, which terminates in gangrene or fever.

IV. Of direct ocular spectra.

A quantity of ſtimulus ſomewhat greater than natural excites the retina into ſpaſmodic action, which ceaſes in a few ſeconds.

A certain duration and energy of the ſtimulus of light and colours excites the perfect action of the retina in viſion; for very quick motions are imperceptible to us, as well as very ſlow ones, as the whirling of a top, or the ſhadow on a ſundial. So perfect darkneſs does not affect the eye at all; and exceſs of light produces pain, not viſion.

1. When a fire-coal is whirled round in the dark, a lucid circle remains a conſiderable time in the eye; and that with ſo much vivacity of light, that it is miſtaken for a continuance of the irritation of the object. In the ſame manner, when a fiery me-



teor ſhoots acroſs the night, it appears to leave a long lucid train behind it, part of which, and perhaps ſometimes the whole, is owing to the continuance of the action of the retina after having been thus vividly excited. This is beautifully illuſtrated by the following experiment: fix a paper ſail, three or four inches in diameter, and made like that of a ſmoke jack, in a tube of paſteboard; on looking through the tube at a diſtant proſpect, ſome disjointed parts of it will be ſeen through the narrow intervals between the ſails; but as the fly begins to revolve, theſe intervals appear larger; and when it revolves quicker, the whole proſpect is ſeen quite as diſtinct as if nothing intervened, though leſs luminous.

2. Look through a dark tube, about half a yard long, at the area of a yellow circle of half an inch diameter, lying upon a blue area of double that diameter, for half a minute; and on cloſing your eyes the colours of the ſpectrum will appear ſimilar to the two areas, as in fig. 3.; but if the eye is kept too long upon them, the colours of the ſpectrum will be the reverſe of thoſe upon the paper, that is, the internal circle will become blue, and the external area yellow; hence ſome attention is required in making this experiment.

3. Place the bright flame of a ſpermaceti candle before a black object in the night; look ſtea-

dily at it for a ſhort time, till it is obſerved to become ſomewhat paler; and on cloſing the eyes, and covering them carefully, but not ſo as to compreſs them, the image of the blazing candle will continue diſtinctly to be viſible.

Look ſteadily, for a ſhort time, at a window in a dark day, as in Exp. 2. Sect. III. and then cloſing your eyes, and covering them with your hands, an exact delineation of the window remains for ſome time viſible in the eye. This experiment requires a little practice to make it ſucceed well; ſince, if the eyes are fatigued by looking too long on the window, or the day be too bright, the luminous parts of the window will appear dark in the ſpectrum, and the dark parts of the frame-work will appear luminous, as in Exp. 2. Sect. III. And it is even difficult for many, who firſt try this experiment, to perceive the ſpectrum at all; for any hurry of mind, or even too great attention to the ſpectrum itſelf, will diſappoint them, till they have had a little experience in attending to ſuch ſmall ſenſations.

The ſpectra deſcribed in this ſection, termed direct ocular ſpectra, are produced without much fatigue of the eye; the irritation of the luminous object being ſoon withdrawn, or its quantity of light being not ſo great as to produce any degree of uneaſineſs in the organ of viſion; which diſtinguiſhes them from the next claſs of ocular ſpectra, which are the conſequence of fatigue.

Theſe direct ſpectra are beſt obſerved in ſuch circumſtances that no light, but what comes from the object, can fall upon the eye; as in looking through a tube, of half a yard long, and an inch wide, at a yellow paper on the ſide of a room, the direct ſpectrum was eaſily produced on cloſing the eye without taking it from the tube; but if the lateral light is admitted through the eyelids, or by throwing the ſpectrum on white paper, it becomes a reverſe ſpectrum, as will be explained below.

The other ſenſes alſo retain for a time the impreſſions that have been made upon them, or the actions they have been excited into. So if a hard body is preſſed upon the palm of the hand, as is practiſed in tricks of legerdemain, it is not eaſy to diſtinguiſh for a few ſeconds whether it remains or is removed; and taſtes continue long to exiſt vividly in the mouth, as the ſmoke of tobacco, or the taſte of gentian, after the ſapid material is withdrawn.

V. *A quantity of ſtimulus ſomewhat greater than the laſt mentioned excites the retina into ſpaſmodic action, which ceaſes and recurs alternately.*

1. On looking for a time on the ſetting ſun, ſo as not greatly to fatigue the ſight, a yellow ſpectrum is ſeen when the eyes are cloſed and covered, which continues for a time, and then

diſappears and recurs repeatedly before it entirely vaniſhes. This yellow ſpectrum of the ſun when the eyelids are opened becomes blue; and if it is made to fall on the green graſs, or on other coloured objects, it varies its own colour by an intermixture of theirs, as will be explained in another place.

2. Place a lighted ſpermaceti candle in the night about one foot from your eye, and look ſteadily on the centre of the flame, till your eye becomes much more fatigued than in Sect. IV. Exp. 3.; and on cloſing your eyes a reddiſh ſpectrum will be perceived, which will ceaſe and return alternately.

The action of vomiting in like manner ceaſes, and is renewed by intervals, although the emetic drug is thrown up with the firſt effort: ſo after-pains continue ſome time after parturition; and the alternate pulſations of the heart of a viper are renewed for ſome time after it is cleared from its blood.

VI. Of reverse ocular spectra.

The retina, after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned, falls into oppoſite ſpaſmodic action.

The actions of every part of animal bodies may be advantageouſly compared with each other.

This ſtrict analogy contributes much to the inveſtigation of truth; while thoſe looſer analogies, which compare the phenomena of animal life with thoſe of chemiſtry or mechanics, only ſerve to miſlead our inquiries.

When any of our larger muſcles have been in long or in violent action, and their antagoniſts have been at the ſame time extended, as ſoon as the action of the former ceaſes, the limb is ſtretched the contrary way for our eaſe, and a pandiculation or yawning takes place.

By the following obſervations it appears, that a ſimilar circumſtance obtains in the organ of viſion; after it has been fatigued by one kind of action, it ſpontaneouſly falls into the oppoſite kind.

1. Place a piece of coloured ſilk, about an inch in diameter, on a ſheet of white paper, about half a yard from your eyes; look ſteadily upon it for a minute; then remove your eyes upon another part of the white paper, and a ſpectrum will be ſeen of the form of the ſilk thus inſpected, but of a colour oppoſite to it. A ſpectrum nearly ſimilar will appear if the eyes are cloſed, and the eyelids ſhaded by approaching the hand near them, ſo as to permit ſome, but to prevent too much light falling on them.

Red ſilk produced a green ſpectrum.

Green produced a red one.

Orange produced blue.
Blue produced orange.
Yellow produced violet.
Violet produced yellow.

That in theſe experiments the colours of the ſpectra are the reverſe of the colours which occaſioned them, may be ſeen by examining the third figure in Sir Iſaac Newton's Optics, L. II. p. 1. where thoſe thin laminæ of air, which reflected yellow, tranſmitted violet; thoſe which reflected red, tranſmitted a blue green; and ſo of the reſt, agreeing with the experiments above related.

2. Theſe reverſe ſpectra are ſimilar to a colour, formed by a combination of all the primary colours except that with which the eye has been fatigued in making the experiment: thus the reverſe ſpectrum of red muſt be ſuch a green as would be produced by a combination of all the other priſmatic colours. To evince this fact the following ſatisfactory experiment was made. The priſmatic colours were laid on a circular paſteboard wheel, about four inches in diameter, in the proportions deſcribed in Dr. Prieſtley's Hiſtory of Light and Colours, pl. 12. fig. 83. except that the red compartment was entirely left out, and the others proportionably extended ſo as to complete the circle. Then, as the orange is a mixture of red and yellow, and as the violet is a mixture of red and indigo, it became neceſſary to

put

put yellow on the wheel inſtead of orange, and indigo inſtead of violet, that the experiment might more exactly quadrate with the theory it was deſigned to eſtabliſh or confute; becauſe in gaining a green ſpectrum from a red object, the eye is ſuppoſed to have become inſenſible to red light. This wheel, by means of an axis, was made to whirl like a top; and on its being put in motion, a green colour was produced, correſponding with great exactneſs to the reverſe ſpectrum of red.

3. In contemplating any one of theſe reverſe ſpectra in the cloſed and covered eye, it diſappears and re-appears ſeveral times ſucceſſively, till at length it entirely vaniſhes, like the direct ſpectra in Sect. V.; but with this additional circumſtance, that when the ſpectrum becomes faint or evaneſcent, it is inſtantly revived by removing the hand from before the eyelids, ſo as to admit more light: becauſe then not only the fatigued part of the retina is inclined ſpontaneouſly to fall into motions of a contrary direction, but being ſtill ſenſible to all other rays of light, except that with which it was lately fatigued, is by theſe rays at the ſame time ſtimulated into thoſe motions which form the reverſe ſpectrum.

From theſe experiments there is reaſon to conclude, that the fatigued part of the retina throws itſelf into a contrary mode of action, like oſcitation or pandiculation, as ſoon as the ſtimulus which has fatigued it is withdrawn; and that it ſtill remains ſenſible, that is, liable to be excited into action by any other colours at the ſame time, except the colour with which it has been fatigued.

VII. *The retina after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned falls into various ſucceſſive ſpaſmodic actions.*

1. On looking at the meridian ſun as long as the eyes can well bear its brightneſs, the diſk firſt becomes pale, with a luminous creſcent, which ſeems to librate from one edge of it to the other, owing to the unſteadineſs of the eye; then the whole phaſis of the ſun becomes blue, ſurrounded with a white halo; and on cloſing the eyes, and covering them with the hands, a yellow ſpectrum is ſeen, which in a little time changes into a blue one.

M. de la Hire obſerved, after looking at the bright ſun, that the impreſſion in his eye firſt aſſumed a yellow appearance, and then green, and then blue; and wiſhes to aſcribe theſe appearances to ſome affection of the nerves. (Porterfield on the Eye, Vol. I. p. 343.)

2. After looking ſteadily on about an inch ſquare of pink ſilk, placed on white paper, in a

bright ſunſhine, at the diſtance of a foot from my eyes, and cloſing and covering my eye-lids, the ſpectrum of the ſilk was at firſt a dark green, and the ſpectrum of the white paper became of a pink. The ſpectra then both diſappeared; and then the internal ſpectrum was blue; and then, after a ſecond diſappearance, became yellow, and laſtly pink, whilſt the ſpectrum of the field varied into red and green.

Theſe ſucceſſions of different coloured ſpectra were not exactly the ſame in the different experiments, though obſerved, as near as could be, with the ſame quantity of light, and other ſimilar circumſtances; owing, I ſuppoſe, to trying too many experiments at a time; ſo that the eye was not quite free from the ſpectra of the colours which were previouſly attended to.

The alternate exertions of the retina in the preceding ſection reſembled the oſcitation or pandiculation of the muſcles, as they were performed in directions contrary to each other, and were the conſequence of fatigue rather than of pain. And in this they differ from the ſucceſſive diſſimilar exertions of the retina, mentioned in this ſection, which reſemble in miniature the more violent agitations of the limbs in convulſive diſeaſes, as epilepſy, chorea S. Viti, and opiſthotonos; all which diſeaſes are perhaps, at firſt, the conſequence of pain, and have their periods afterwards eſtabliſhed by habit.

VIII. *The retina, after having been excited into action by a ſtimulus ſomewhat greater than the laſt mentioned, falls into a fixed ſpaſmodic action, which continues for ſome days.*

1. After having looked long at the meridian ſun, in making ſome of the preceding experiments, till the diſk faded into a pale blue, I frequently obſerved a bright blue ſpectrum of the ſun on other objects all the next and the ſucceeding day, which conſtantly occurred when I attended to it, and frequently when I did not previouſly attend to it. When I cloſed and covered my eyes, this appeared of a dull yellow; and at other times mixed with the colours of other objects on which it was thrown. It may be imagined, that this part of the retina was become inſenſible to white light, and thence a bluiſh ſpectrum became viſible on all luminous objects; but as a yellowiſh ſpectrum was alſo ſeen in the cloſed and covered eye, there can remain no doubt of this being the ſpectrum of the ſun. A ſimilar appearance was obſerved by M. Æpinus, which he acknowledges he could give no account of. (Nov. Com. Petrop. V. 10. p. 2. and 6.)

The locked jaw, and ſome cataleptic ſpaſms, are reſembled by this phenomenon; and from hence we may learn the danger to the eye by inſpecting very luminous objects too long a time.

IX. *A quantity of ſtimulus greater than the preceding induces a temporary paralyſis of the organ of viſion.*

1. PLACE a circular piece of bright red ſilk, about half an inch in diameter, on the middle of a ſheet of white paper; lay them on the floor in a bright ſunſhine, and fixing your eyes ſteadily on the centre of the red circle, for three or four minutes, at the diſtance of four or ſix feet from the object, the red ſilk will gradually become paler, and finally ceaſe to appear red at all.

2. Similar to theſe are many other animal facts; as purges, opiates, and even poiſons, and contagious matter, ceaſe to ſtimulate our ſyſtem, after we have been habituated to their uſe. So ſome people ſleep undiſturbed by a clock, or even by a forge hammer in their neighbourhood: and not only continued irritations, but violent exertions of any kind, are ſucceeded by temporary paralyſis. The arm drops down after violent action, and continues for a time uſeleſs; and it is probable, that thoſe who have periſhed ſuddenly in ſwimming, or in ſcating on the ice, have owed their deaths to the paralyſis, or extreme fatigue, which ſucceeds every violent and continued exertion.

X. MISCELLANEOUS REMARKS.

THERE were ſome circumſtances occurred in making theſe experiments, which were liable to alter the reſults of them, and which I ſhall here mention for the aſſiſtance of others, who may wiſh to repeat them.

1. *Of direct and inverſe ſpectra exiſting at the ſame time; of reciprocal direct ſpectra; of a combination of direct and inverſe ſpectra; of a ſpectral halo; rules to pre-determine the colours of ſpectra.*

a. When an area, about ſix inches ſquare, of bright pink Indian paper, had been viewed on an area, about a foot ſquare, of white writing paper, the internal ſpectrum in the cloſed eye was green, being the reverſe ſpectrum of the pink paper; and the external ſpectrum was pink, being the direct ſpectrum of the pink paper. The ſame circumſtance happened when the internal area was white, and external one pink; that is, the internal ſpectrum was pink, and the external one green. All the ſame appearances occurred when the pink paper was laid on a black hat.

b. When ſix inches ſquare of deep violet poliſhed paper were viewed on a foot ſquare of white writing paper, the internal ſpectrum were yellow, being the reverſe ſpectrum of the violet paper, and the external one was violet, being the direct ſpectrum of the violet paper.

c. When ſix inches ſquare of pink paper were viewed on a foot ſquare of blue paper, the internal ſpectrum was blue, and the external ſpectrum was pink; that is, the internal one was the direct ſpectrum of the external object, and the external one was the direct ſpectrum of the internal object, inſtead of their being each the reverſe ſpectrum of the objects they belonged to.

d. When ſix inches ſquare of blue paper were viewed on a foot ſquare of yellow paper, the interior ſpectrum became a brilliant yellow, and the exterior one a brilliant blue. The vivacity of the ſpectra was owing to their being excited both by the ſtimulus of the interior and exterior objects; ſo that the interior yellow ſpectrum was both the reverſe ſpectrum of the blue paper, and the direct one of the yellow paper; and the exterior blue ſpectrum was both the reverſe ſpectrum of the yellow paper, and the direct one of the blue paper.

e. When the internal area was only a ſquare half-inch of red paper, laid on a ſquare foot of dark violet paper, the internal ſpectrum was green, with a reddiſh-blue halo. When the red internal paper was two inches ſquare, the internal ſpectrum was a deeper green, and the external one redder. When the internal paper was ſix inches ſquare, the ſpectrum of it became blue, and the ſpectrum of the external paper was red.

f. When a ſquare half-inch of blue paper was laid on a ſix-inch ſquare of yellow paper, the ſpectrum of the central paper in the cloſed eye was yellow, incircled with a blue halo. On looking long on the meridian ſun, the diſk fades into a pale blue ſurrounded with a whitiſh halo.

Theſe circumſtances, though they very much perplexed the experiments till they were inveſtigated, admit of a ſatisfactory explanation; for while the rays from the bright internal object in exp. *a.* fall with their full force on the centre of the retina, and, by fatiguing that part of it, induce the reverſe ſpectrum, many ſcattered rays, from the ſame internal pink paper, fall on the more external parts of the retina, but not in ſuch quantity as to occaſion much fatigue, and hence induce the direct ſpectrum of the pink colour in thoſe parts of the eye. The ſame reverſe and direct ſpectra occur from the violet paper in exp. *b.*: and in exp. *c.* the ſcattered rays from the central pink paper produce a direct ſpectrum of this colour on the external parts of the eye, while the ſcattered rays from the external blue paper produce a direct ſpectrum of that colour on the central part of the eye, inſtead of theſe parts of the retina falling reciprocally into their reverſe ſpectra. In exp. *d.* the colours being the reverſe of each other, the ſcattered rays from the exterior object falling on the central parts of the eye, and there exciting their direct ſpectrum, at the ſame time that the retina was excited into a reverſe ſpectrum by the central object, and this direct and reverſe ſpectrum being of ſimilar colour, the ſuperior brilliancy of this ſpectrum was produced. In exp. *e.* the effect of various quantities of ſtimulus on the retina, from the different reſpective ſizes of the internal and external areas, induced a ſpectrum of the internal area in the centre of the eye, combined of the reverſe ſpectrum of that internal area and the direct one of the external area, in various ſhades of colour, from a pale green to a deep blue, with ſimilar changes in the ſpectrum of the external area. For the ſame reaſons, when an internal bright object was ſmall, as in exp. *f.* inſtead of the whole of the ſpectrum of the external object being reverſe to the colour of the internal object, only a kind of halo, or radiation of colour, ſimilar to that of the internal object, was ſpread a little way on the external ſpectrum. For this internal blue area being ſo ſmall, the ſcattered rays from it extended but a little way on the image of the external area of yellow paper, and could therefore produce only a blue halo round the yellow ſpectrum in the centre.

If any one ſhould ſuſpect that the ſcattered rays from the exterior coloured object do not intermix with the rays from the interior coloured object, and thus affect the central part of the eye, let him look through an opake tube, about two feet in length, and an inch in diameter, at a coloured wall of a room with one eye, and with the other eye naked; and he will find, that by ſhutting out the lateral light, the area of the wall ſeen through a tube appears as if illuminated by the ſunſhine, compared with the other parts of it; from whence ariſes the advantage of looking through a dark tube at diſtant paintings.

Hence we may ſafely deduce the following rules to determine before-hand the colours of all ſpectra. 1. The direct ſpectrum without any lateral light is an evaneſcent repreſentation of its object in the unfatigued eye. 2. With ſome lateral light it becomes of a colour combined of the direct ſpectrum of the central object, and of the circumjacent objects, in proportion to their reſpective quantity and brilliancy. 3. The reverſe ſpectrum without lateral light is a repreſentation in the fatigued eye of the form of its objects, with ſuch a colour as would be produced by all the primary colours, except that of the object. 4. With lateral light the colour is compounded of the reverſe ſpectrum of the central object, and the direct ſpectrum of the circumjacent objects, in proportion to their reſpective quantity and brilliancy.

2. *Variation and vivacity of the ſpectra occaſioned by extraneous light.*

The reverſe ſpectrum, as has been before explained, is ſimilar to a colour, formed by a combination of all the primary colours, except that with which the eye has been fatigued in making the experiment: ſo the reverſe ſpectrum of red is ſuch a green as would be produced by a combination of all the other priſmatic colours. Now it muſt be obſerved, that this reverſe ſpectrum of red is therefore the direct ſpectrum of a combination of all the other priſmatic colours, except the red; whence, on removing the eye from a piece of red ſilk to a ſheet of white paper, the green ſpectrum, which is perceived, may either be called the reverſe ſpectrum of the red ſilk, or the direct ſpectrum of all the rays from the white paper, except the red; for in truth it is both. Hence we ſee the reaſon why it is not eaſy to gain a direct ſpectrum of any coloured object in the day-time, where there is much lateral light, except of very bright objects, as of the ſetting ſun, or by looking through an opake tube; becauſe the lateral external light falling alſo on the central part of the retina, contributes to induce the reverſe ſpectrum, which is at the ſame time the direct ſpectrum of that lateral light, deducting only the colour of the central object which we have been viewing. And for the ſame reaſon, it is difficult to gain the reverſe ſpectrum, where there is no lateral light to contribute to its formation. Thus, in looking through an opake tube on a yellow wall, and cloſing my eye, without admitting any lateral light, the ſpectra were all at firſt yellow; but at length changed into blue. And on looking in the ſame manner on red paper, I did at length get a green ſpectrum; but they were all at firſt red ones: and the ſame after looking at a candle in the night.

The reverſe ſpectrum was formed with greater facility when the eye was thrown from the object on a ſheet of white paper, or when light was admitted through the cloſed eyelids; becauſe not only the fatigued part of the retina was inclined ſpontaneouſly to fall into motions of a contrary direction; but being ſtill ſenſible to all other rays of light except that with which it was lately fatigued, was by theſe rays ſtimulated at the ſame time into thoſe motions which form the reverſe ſpectrum. Hence, when the reverſe ſpectrum of any colour became faint, it was wonderfully revived by admitting more light through the eyelids, by removing the hand from before them: and hence, on covering the cloſed eyelids, the ſpectrum would often ceaſe for a time, till the retina became ſenſible to the ſtimulus of the ſmaller quantity of light, and then it recurred. Nor was the ſpectrum only changed in vivacity, or in degree, by this admiſſion of light through the eyelids; but it frequently happened, after having viewed bright objects, that the ſpectrum in the cloſed and covered eye was changed into a third ſpectrum, when light was admitted through the eyelids: which third ſpectrum was compoſed of ſuch colours as could paſs through the eyelids, except thoſe of the object. Thus, when an area of half an inch diameter of pink paper was viewed on a ſheet of white paper in the ſunſhine, the ſpectrum with cloſed and covered eyes was green; but on removing the hands from before the cloſed eyelids, the ſpectrum became yellow, and returned inſtantly again to green, as often as the hands were applied to cover the eyelids, or removed from them: for the retina being now inſenſible to red light, the yellow rays paſſing through the eyelids in greater quantity than the other colours, induced a yellow ſpectrum; whereas if the ſpectrum was thrown on white paper, with the eyes open, it became only a lighter green.

Though a certain quantity of light facilitates the formation of the reverſe ſpectrum, a greater quantity prevents its formation, as the more powerful ſtimulus excites even the fatigued parts of the eye into action; otherwiſe we ſhould ſee the ſpectrum of the laſt viewed object as often as we turn our eyes. Hence the reverſe ſpectra are beſt ſeen by gradually approaching the hand near the cloſed eyelids to a certain diſtance only, which muſt be varied with the brightneſs of the day, or the energy of the ſpectrum. Add to this, that all dark ſpectra, as black, blue, or green, if light be admitted through the eyelids, after they have been ſome time covered, give reddiſh ſpectra, for the reaſons given in Sect. III. Exp. 1.

From theſe circumſtances of the extraneous light coinciding with the ſpontaneous efforts of the fatigued retina to produce a reverſe ſpectrum, as was obſerved before, it is not eaſy to gain a direct ſpectrum, except of objects brighter than the ambient light; ſuch as a candle in the night, the ſetting ſun, or viewing a bright object through an opake tube; and then the reverſe ſpectrum is inſtantaneouſly produced by the admiſſion of ſome external light; and is as inſtantly converted again to the direct ſpectrum by the excluſion of it. Thus, on looking at the ſetting ſun, on cloſing the eyes, and covering them, a yellow ſpectrum is ſeen, which is the direct ſpectrum of the ſetting ſun; but on opening the eyes on the ſky, the yellow ſpectrum is immediately changed into a blue one, which is the reverſe ſpectrum of the yellow ſun, or the direct ſpectrum of the blue ſky, or a combination of both. And this is again transformed into a yellow one on cloſing the eyes, and ſo reciprocally, as quick as the motions of the opening and cloſing eyelids. Hence, when Mr. Melvill obſerved

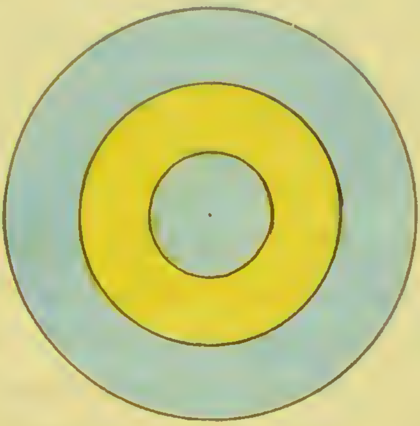
ſerved the ſcintillations of the ſtar Sirius to be ſometimes coloured, theſe were probably the direct ſpectrum of the blue ſky on the parts of the retina fatigued by the white light of the ſtar. (Eſſays Phyſical and Literary, p. 81. V. 2.)

When a direct ſpectrum is thrown on colours darker than itſelf, it mixes with them; as the yellow ſpectrum of the ſetting ſun, thrown on the green graſs, becomes a greener yellow. But when a direct ſpectrum is thrown on colours brighter than itſelf, it becomes inſtantly changed into the reverſe ſpectrum, which mixes with thoſe brighter colours. So the yellow ſpectrum of the ſetting ſun thrown on the luminous ſky becomes blue, and changes with the colour or brightneſs of the clouds on which it appears. But the reverſe ſpectrum mixes with every kind of colour on which it is thrown, whether brighter than itſelf or not: thus the reverſe ſpectrum, obtained by viewing a piece of yellow ſilk, when thrown on white paper, was a lucid blue green; when thrown on black Turkey leather, becomes a deep violet. And the ſpectrum of blue ſilk, thrown on white paper, was a light yellow; on black ſilk was an obſcure orange; and the blue ſpectrum, obtained from orange-coloured ſilk, thrown on yellow, became a green.

In theſe caſes the retina is thrown into activity or ſenſation by the ſtimulus of external colours, at the ſame time that it continues the activity or ſenſation which forms the ſpectra; in the ſame manner as the priſmatic colours, painted on a whirling top, are ſeen to mix together. When theſe colours of external objects are brighter than the direct ſpectrum which is thrown upon them, they change it into the reverſe ſpectrum, like the admiſſion of external light on a direct ſpectrum, as explained above. When they are darker than the direct ſpectrum, they mix it, their weaker ſtimulus being inſufficient to induce the reverſe ſpectrum.

3. *Variation of ſpectra in reſpect to number, and figure, and remiſſion.*

When we look long and attentively at any object, the eye cannot always be kept entirely motionleſs; hence, on inſpecting a circular area of red ſilk placed on white paper, a lucid creſcent or edge is ſeen to librate on one ſide or other of the red circle: for the exterior parts of the retina ſometimes falling on the edge of the central ſilk, and ſometimes on the white paper, are leſs fatigued with red light than the central part of the retina, which is conſtantly expoſed to it; and therefore, when they fall on the edge of the red ſilk, they perceive it more vividly. Afterwards, when the eye becomes fatigued, a green ſpectrum in the form of a creſcent is ſeen to librate on one ſide or other of the central circle,



as by the unſteadineſs of the eye a part of the fatigued retina falls on the white paper; and as by the increaſing fatigue of the eye the central part of the ſilk appears paler, the edge on which the unfatigued part of the retina occaſionally falls will appear of a deeper red than the original ſilk, becauſe it is compared with the pale internal part of it. M. de Buffon in making this experiment obſerved, that the red edge of the ſilk was not only deeper coloured than the original ſilk; but, on his retreating a little from it, it became oblong, and at length divided into two, which muſt have been owing to his obſerving it either before or behind the point of interſection of the two optic axiſes. Thus, if a pen is held up before a diſtant candle, when we look intenſely at the pen two candles are ſeen behind it; when we look intenſely at the candle two pens are ſeen. If the ſight be unſteady at the time of beholding the ſun, even though one eye only be uſed, many images of the ſun will appear, or luminous lines, when the eye is cloſed. And as ſome parts of theſe will be more vivid than others, and ſome parts of them will be produced nearer the centre of the eye than others, theſe will diſappear ſooner than the others; and hence the number and ſhape of theſe ſpectra of the ſun will continually vary, as long as they exiſt. The cauſe of ſome being more vivid than others, is the unſteadineſs of the eye of the beholder, ſo that ſome parts of the retina have been longer expoſed to the ſun-beams. That ſome parts of a complicated ſpectrum fade and return before other parts of it, the following experiment evinces. Draw three concentric circles; the external one an inch and a half in diameter, the middle one an inch, and the internal one half an inch; colour the external and internal areas blue, and the remaining one yellow, as in Fig. 4.; after having looked about a minute on the centre of theſe circles, in a bright light, the ſpectrum of the external area appears firſt in the cloſed eye, then the middle area, and laſtly the central one; and then the central one diſappears, and the others in inverted order. If concentric circles of more colours are added, it produces the beautiful ever changing ſpectrum in Sect. I. Exp. 2.

From hence it would ſeem, that the centre of the eye produces quicker remiſſions of ſpectra, owing perhaps to its greater ſenſibility; that is to its more energetic exertions. Theſe remiſſions of ſpectra bear ſome analogy to the tremors of the hands, and palpitations of the heart, of weak people: and perhaps a criterion of the ſtrength of any muſcle or nerve may be taken from the time it can be continued in exertion.

4. *Variation of ſpectra in reſpect to brilliancy; the viſibility of the circulation of the blood in the eye.*

1. The meridian or evening light makes a difference in the colours of ſome ſpectra; for as the ſun deſcends, the red rays, which are leſs refrangible by the convex atmoſphere, abound in great quantity. Whence the ſpectrum of the light parts of a window at this time, or early in the morning, is red; and becomes blue either a little later or earlier; and white in the meridian day; and is alſo variable from the colour of the clouds or ſky which are oppoſed to the window.

2. All theſe experiments are liable to be confounded, if they are made too ſoon after each other, as the remaining ſpectrum will mix with the new ones. This is a very troubleſome circumſtance to painters, who are obliged to look long upon the ſame colour; and in particular to thoſe whoſe eyes, from natural debility, cannot long continue the ſame kind of exertion. For the ſame reaſon, in making theſe experiments, the reſult becomes much varied if the eyes, after viewing any object, are removed on other objects for but an inſtant of time, before we cloſe them to view the ſpectrum; for the light from the object, of which we had only a tranſient view, in the very time of cloſing our eyes acts as a ſtimulus on the fatigued retina; and for a time

prevents the deſired ſpectrum from appearing, or mixes its own ſpectrum with it. Whence, after the eyelids are cloſed, either a dark field, or ſome unexpected colours, are beheld for a few ſeconds, before the deſired ſpectrum becomes diſtinctly viſible.

3. The length of time taken up in viewing an object, of which we are to obſerve the ſpectrum, makes a great difference in the appearance of the ſpectrum, not only in its vivacity, but in its colour; as the direct ſpectrum of the central object, or of the circumjacent ones, and alſo the reverſe ſpectra of both, with their various combinations, as well as the time of their duration in the eye, and of their remiſſions or alterations, depend upon the degree of fatigue the retina is ſubjected to. The Chevalier d'Arcy conſtructed a machine by which a coal of fire was whirled round in the dark, and found, that when a luminous body made revolution in eight thirds of time, is preſented to the eye a complete circle of fire; from whence he concludes, that the impreſſion continues on the organ about the ſeventh part of a ſecond. (Mém. de l'Acad. des Sc. 1765.) This, however, is only to be conſidered as the ſhorteſt time of the duration of theſe direct ſpectra; ſince in the fatigued eye both the direct and reverſe ſpectra, with their intermiſſions, appear to take up many ſeconds of

time, and ſeem very variable in proportion to the circumſtances of fatigue or energy.

4. It ſometimes happens, if the eyeballs have been rubbed hard with the fingers, that lucid ſparks are ſeen in quick motion amidſt the ſpectrum we are attending to. This is ſimilar to the flaſhes of fire from a ſtroke on the eye in fighting, and is reſembled by the warmth and glow, which appears upon the ſkin after friction, and is probably owing to an acceleration of the arterial blood into the veſſels emptied by the previous preſſure. By being accuſtomed to obſerve ſuch ſmall ſenſations in the eye, it is eaſy to ſee the circulation of the blood in this organ. I have attended to this frequently, when I have obſerved my eyes more than commonly ſenſible to other ſpectra. The circulation may be ſeen either in both eyes at a time, or only in one of them; for as a certain quantity of light is neceſſary to produce this curious phenomenon, if one hand be brought nearer the cloſed eyelids than the other, the circulation in that eye will for a time diſappear. For the eaſier viewing the circulation, it is ſometimes neceſſary to rub the eyes with a certain degree of force after they are cloſed, and to hold the breath rather longer than is agreeable, which, by accumulating more blood in the eye, facilitates the experiment; but in general it may be ſeen diſtinctly after having examined other ſpectra with your back to the

light till the eyes become weary; then having covered your cloſed eyelids for half a minute, till the ſpectrum is faded away which you were examining, turn your face to the light, and removing your hands from the eyelids, by and by again ſhade them a little, and the circulation becomes curiouſly diſtinct. The ſtreams of blood are however generally ſeen to unite, which ſhews it to be the venous circulation, owing, I ſuppoſe, to the greater opacity of the colour of the blood in theſe veſſels; for this venous circulation is alſo much more eaſily ſeen by the microſcope in the tail of a tadpole.

5. *Variation of ſpectra in reſpect to diſtinctneſs and ſize; with a new way of magnifying objects.*

1. It was before obſerved, that when the two colours viewed together were oppoſite to each other, as yellow and blue, red and green, &c. according to the table of reflections and tranſmiſſions of light in Sir Iſaac Newton's Optics, B. II. Fig. 3. the ſpectra of thoſe colours were of all others the moſt brilliant, and beſt defined; becauſe they were combined of the reverſe ſpectrum of one colour, and of the direct ſpectrum of the other. Hence, in books printed with ſmall types, or in the minute graduation of thermome-

BANKS.

ters, or of clock-faces, which are to be ſeen at a diſtance, if the letters or figures are coloured with orange, and the ground with indigo; or the letters with red, and the ground with green; or any other lucid colour is uſed for the letters, the ſpectrum of which is ſimilar to the colour of the ground; ſuch letters will be ſeen much more diſtinctly, and with leſs confuſion, than in black or white: for as the ſpectrum of the letter is the ſame colour with the ground on which they are ſeen, the unſteadineſs of the eye in long attending to them will not produce coloured lines by the edges of the letters, which is the principal cauſe of their confuſion. The beauty of colours lying in vicinity to each other, whoſe ſpectra are thus reciprocally ſimilar to each colour, is owing to this greater eaſe that the eye experiences in beholding them diſtinctly; and it is probable, in the organ of hearing, a ſimilar circumſtance may conſtitute the pleaſure of melody. Sir Iſaac Newton obſerves, that gold and indigo were agreeable when viewed together; and thinks there may be ſome analogy between the ſenſations of light and ſound. (Optics, Qu. 14.)

In viewing the ſpectra of bright objects, as of an area of red ſilk of half an inch diameter on white paper, it is eaſy to magnify it to tenfold its ſize: for if, when the ſpectrum is formed, you ſtill keep your eye fixed on the ſilk area, and remove it a few inches further from you, a green circle is ſeen round the red ſilk; for the angle now ſubtended by the ſilk is leſs than it was when the ſpectrum was formed, but that of the ſpectrum continues the ſame, and our imagination places them at the ſame diſtance. Thus when you view a ſpectrum on a ſheet of white paper, if you approach the paper to the eye, you may diminiſh it to a point; and if the paper is made to recede from the eye, the ſpectrum will appear magnified in proportion to the diſtance.

I was ſurpriſed, and agreeably amuſed, with the following experiment. I covered a paper about four inches ſquare with yellow, and with a pen filled with a blue colour wrote upon the middle of it the word BANKS in capitals, as in fig. 5, and ſitting with my back to the ſun, fixed my eyes for a minute exactly on the centre of the letter N in the middle of the word; after cloſing my eyes, and ſhading them ſomewhat with my hand, the word was diſtinctly ſeen in the ſpectrum in yellow letters on a blue field; and then, on opening my eyes on a yellowiſh wall at twenty feet diſtance, the magnified name of BANKS appeared written on the wall in golden characters.

6. *Concluſion.*

It was obſerved by the learned M. Sauvages (Noſol. Method. Cl. VIII. Ord. i.) that the pulſations of the optic artery might be perceived by looking attentively on a white wall well illuminated. A kind of net-work, darker than the other parts of the wall, appears and vaniſhes alternately with every pulſation. This change of the colour of the wall he well aſcribes to the compreſſion of the retina by the diaſtole of the artery. The various colours produced in the eye by the preſſure of the finger, or by a ſtroke on it, as mentioned by Sir Iſaac Newton, ſeem likewiſe to originate from the unequal preſſure on various parts of the retina. Now as Sir Iſaac Newton has ſhewn, that all the different colours are reflected or tranſmitted by the laminæ of ſoap bubbles, or of air, according to their different thickneſs or thinneſs, is it not probable, that the effect of the activity of the retina may be to alter its thickneſs or thinneſs, ſo as better to adapt it to reflect or tranſmit the colours which ſtimulate it into action? May not muſcular fibres exiſt in the retina for this purpoſe, which may be leſs minute than the locomotive muſcles of microſcopic animals? May not theſe muſcular actions of the retina conſtitute the ſenſation of light and colours; and the voluntary re-

petitions

petitions of them, when the object is withdrawn, conſtitute our memory of them? And laſtly, may not the laws of the ſenſations of light, here inveſtigated, be applicable to all our other ſenſes, and much contribute to elucidate many phenomena of animal bodies both in their healthy and diſeaſed ſtate; and thus render this inveſtigation well worthy the attention of the phyſician, the metaphyſician, and the natural philoſopher?

November 1, 1785.

Dum, Liber! aſtra petis volitans trepidantibus alis,
Irruis immemori, parvula gutta, mari.
Me quoque, me currente rotâ revolubilis ætas
Volverit in tenebras,—i, Liber, ipſe ſequor.

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END OF THE FIRST PART.

ZOONOMIA;

OR,

THE LAWS OF ORGANIC LIFE.

PART III.

CONTAINING

THE ARTICLES OF THE MATERIA MEDICA,

WITH AN ACCOUNT OF THE

OPERATION OF MEDICINES.

IN VIVUM CORPUS
AGUNT MEDICAMENTA.

PREFACE.

THE MATERIA MEDICA includes all thoſe ſubſtances, which may contribute to the reſtoration of health. Theſe may be conveniently diſtributed under ſeven articles according to the diverſity of their operations.

1. NUTRIENTIA, or thoſe things which preſerve in their natural ſtate the due exertions of all the irritative motions.

2. INCITANTIA, or thoſe things which increaſe the exertions of all the irritative motions.

3. SECERNENTIA, or thoſe things which increaſe the irritative motions, which conſtitute ſecretion.

4. SORBENTIA, or thoſe things which increaſe the irritative motions, which conſtitute abſorption.

5. INVERTENTIA, or thoſe things which invert the natural order of the ſucceſſive irritative motions.

6. Revertentia, or thoſe things which reſtore the natural order of the inverted irritative motions.

7. Torpentia, thoſe things which diminiſh the exertions of all the irritative motions.

It is neceſſary to apprize the reader, that in the following account of the virtues of Medicines their uſual doſes are always ſuppoſed to be exhibited; and the patient to be expoſed to the degree of exterior heat, which he has been accuſtomed to, (where the contrary is not mentioned), as any variation of either of theſe circumſtances varies their effects.

ARTICLES

OF THE

MATERIA MEDICA.

ART. I.

NUTRIENTIA.

I. 1. THOSE THINGS, which preſerve in their natural ſtate the due exertions of all the irritative motions, are termed nutrientia; they produce the growth, and reſtore the waſte, of the ſyſtem. Theſe conſiſt of a variety of mild vegetable and animal ſubſtances, water, and air.

2. Where ſtronger ſtimuli have been long uſed, they become neceſſary for this purpoſe, as muſtard, ſpice, ſalt, beer, wine, vinegar, alcohol, opium. Which however, as they are unnatural ſtimuli, and difficult to manage in reſpect to quantity, are liable to ſhorten the ſpan of human life, ſooner rendering the ſyſtem incapable of being ſtimulated into action by the nutrientia. See Sect. XXXVII. 4. On the ſame account life is ſhorter in warmer climates than in more temperate ones.

3 II. OBSER-

II. OBSERVATIONS ON THE NUTRIENTIA.

I. 1. The fleſh of animals contains more nouriſhment, and ſtimulates our abſorbent and ſecerning veſſels more powerfully, than the vegetable productions, which we uſe as food; for the carnivorous animals can faſt longer without injury than the graminivorous; and we feel ourſelves warmer and ſtronger after a meal of fleſh than of grain. Hence in diſeaſes attended with cold extremities and general debility this kind of diet is preferred; as in rickets, dropſy, ſcrofula, and in hyſteric and hypochondriac caſes, and to prevent the returns of agues. Might not fleſh in ſmall quantities bruiſed to a pulp be more advantageouſly uſed in fevers attended with debility than vegetable diet?

That fleſh, which is of the darkeſt colour, generally contains more nouriſhment, and ſtimulates our veſſels more powerfully, than the white kinds. The fleſh of the carnivorous and piſcivorous animals is ſo ſtimulating, that it ſeldom enters into the food of European nations, except the ſwine, the Soland gooſe (Pelicanus Baſſanus), and formerly the ſwan. Of theſe the ſwine and the ſwan are fed previouſly upon vegetable aliment; and the Soland gooſe is taken in very ſmall quantity, only as a whet to the appetite. Next to theſe are the birds, that feed upon inſects, which are perhaps the moſt ſtimulating and the moſt nutritive of our uſual food.

It is ſaid that a greater quantity of volatile alkali can be obtained from this kind of fleſh, to which has been aſcribed its ſtimulating quality. But it is more probable, that freſh fleſh contains only the elements of volatile alkali.

2. Next to the dark coloured fleſh of animals, the various tribes of ſhell-fiſh ſeem to claim their place, and the wholeſome kinds of muſhrooms, which muſt be eſteemed animal food, both for their alcaleſcent tendency, their ſtimulating quality, and the quantity of nouriſhment, which they afford; as oyſters, lobſters, crabfiſh, ſhrimps; muſhrooms; to which perhaps might be added ſome of the fiſh without ſcales; as the eel, barbolt, tench, ſmelt, turbot, turtle.

The fleſh of many kinds of fiſh, when it is ſuppoſed to have undergone a beginning putrefaction, becomes luminous in the dark. This ſeems to ſhew a tendency in the phoſphorus to eſcape, and combine with the oxygen of the atmoſphere; and would hence ſhew, that this kind of fleſh is not ſo perfectly animalized as thoſe before mentioned. This light, as it is frequently ſeen on rotten wood, and ſometimes on veal, which has been kept too long, as I have been told, is commonly ſuppoſed to have its cauſe from putrefaction; but is nevertheleſs moſt probably of phoſphoric origin, like that ſeen in the dark on oyſter-ſhells, which have previouſly been ignited and afterwards expoſed to the ſunſhine, and on the Bolognian ſtone. See Botan. Gard. Vol. I. Cant. I. line 182, the note, and additional note X.

3. The fleſh of young animals, as of lamb, veal, and ſucking-pigs, ſupplies us with a ſtill leſs ſtimulating food. The broth of theſe is ſaid to become ſour, and continues ſo a conſiderable time before it changes into putridity; ſo much does their fleſh partake of the chemical properties of the milk, with which theſe animals are nouriſhed.

4. The white meats, as of turkey, partridge, pheaſant, fowl, with their eggs, ſeem to be the next in mildneſs; and hence are generally firſt allowed to convaleſcents from inflammatory diſeaſes.

5. Next to thoſe ſhould be ranked the white river-fiſh, which have ſcales, as pike, perch, gudgeon.

II. 1. Milk unites the animal with the vegetable ſource of our nouriſhment, partaking of the properties of both. As it contains ſugar, and will therefore ferment and produce a kind of wine or ſpirit, which is a common liquor in Siberia; or will run into an acid by ſimple agitation,

tion, as in the churning of cream; and laſtly, as it contains coagulable lymph, which will undergo the proceſs of putrefaction like other animal ſubſtances, as in old cheeſe.

2. Milk may be ſeparated by reſt or by agitation into cream, butter, butter-milk, whey, curd. The cream is eaſier of digeſtion to adults, becauſe it contains leſs of the coagulum or cheeſy part, and is alſo more nutritive. Butter conſiſting of oil between an animal and vegetable kind contains ſtill more nutriment, and in its recent ſtate is not difficult of digeſtion if taken in moderate quantity. See Art. I. 2. 3. 2. Butter-milk if it be not bitter is an agreeable and nutritive fluid; if it be bitter it has ſome putrid parts of the cream in it, which had been kept too long; but is perhaps not leſs wholeſome for being ſour to a certain degree: as the inferior people in Scotland chooſe ſour milk in preference to ſkimmed milk before it is become ſour. Whey is the leaſt nutritive and eaſieſt of digeſtion. And in the ſpring of the year, when the cows feed on young graſs, it contains ſo much of vegetable properties, as to become a ſalutary potation, when drunk to about a pint every morning, to thoſe who during the winter have taken too little vegetable nouriſhment, and who are thence liable to bilious concretions.

3. Cheeſe is of various kinds, according to the greater or leſs quantity of cream, which it contains, and according to its age. Thoſe cheeſes, which are eaſieſt broken to pieces in the mouth, are generally eaſieſt of digeſtion, and contain moſt nutriment. Some kinds of cheeſe, though ſlow of digeſtion, are alſo ſlow in changing by chemical proceſſes in the ſtomach, and therefore will frequently agree well with thoſe, who have a weak digeſtion; as I have ſeen toaſted cheeſe vomited up a whole day after it was eaten without having undergone any apparent change, or given any uneaſineſs to the patient. It is probable a portion of ſugar, or of animal fat, or of the gravy of boiled or roaſted meat, mixed with cheeſe at the time of making it, might add to its pleaſant and nutritious quality.

4. The reaſon, why autumnal milk is ſo much thicker or coagulable than vernal milk, is not eaſy to underſtand; but as new milk is in many reſpects ſimilar to chyle, it may be conſidered as food already in part digeſted by the animal it is taken from, and thence ſupplies a nutriment of eaſy digeſtion. But as it requires to be curdled by the gaſtric acid, before it can enter the lacteals, as is ſeen in the ſtomachs of calves, it ſeems more ſuitable to children, whoſe ſtomachs abound more with acidity, than to adults; but neverthe-

leſs ſupplies good nouriſhment to many of the latter, and particularly to thoſe, who uſe vegetable food, and whoſe ſtomachs have not been much accuſtomed to the unnatural ſtimulus of ſpice, ſalt, and ſpirit. See Claſs I. 1. 2. 5.

III. 1. The ſeeds, roots, leaves, and fruits of plants, conſtitute the greateſt part of the food of mankind; the reſpective quantities of nouriſhment, which theſe contain, may perhaps be eſtimated from the quantity of ſtarch, or of ſugar, they can be made to produce: in farinaceous ſeeds, the mucilage ſeems gradually to be converted into ſtarch, while they remain in our granaries; and the ſtarch by the germination of the young plant, as in making malt from barley, or by animal digeſtion, is converted into ſugar. Hence old wheat and beans contain more ſtarch than new; and in our ſtomachs other vegetable and animal materials are converted into ſugar; which conſtitutes in all creatures a part of their chyle.

Hence it is probable, that ſugar is the moſt nutritive part of vegetables; and that they are more nutritive, as they are convertible in greater quantity into ſugar by the power of digeſtion; as appears from ſugar being found in the chyle of all animals, and from its exiſting in great quantity in the urine of patients in the diabetes, of which a curious caſe is related in Sect. XXIX. 4.

where a man labouring under this malady ate and drank an enormous quantity, and ſometimes voided ſixteen pints of water in a day, with an ounce of ſugar in each pint.

The nutritive quality of ſugar is not only ſhewn by the ſlaves in Jamaica, and other animals, becoming fatter in the ſugar harveſt, though they are forced to labour more, but alſo from the many inſtances of its nouriſhing for ſome years very old people, who could take little of any other food. Many of which caſes are recorded in Dr. Moſely's Treatiſe on Sugar, and three I have myſelf witneſſed.

Nor is this to be wondered at, as it conſtitutes a part of the chyle both of vegetables and animals; which only ſeem to differ from each other in this circumſtance, that the chyle of vegetables conſiſts principally of ſugar and mucilage diſſolved in water; as the juice extracted from birch and maple-trees in the vernal months, and is therefore tranſparent and colourleſs; but the chyle of animals alſo contains oil, mixed with the ſugar and mucilage and water, which gives it its milky appearance, owing to its imperfect ſolution.

2. Oil, when mixed with mucilage or coagulable lymph, as in cream or new milk, is eaſy of digeſtion, and conſtitutes probably the moſt nutritive part of animal diet; as oil is another part of the chyle of all animals. As theſe two mate-

rials, ſugar and butter, contain much nutriment under a ſmall volume, and readily undergo ſome chemical change ſo as to become acid or rancid; they are liable to diſturb weak ſtomachs, when taken in large quantity, more than aliment, which contains leſs nouriſhment, and is at the ſame time leſs liable to chemical changes; becauſe the chyle is produced quicker than the torpid lacteals can abſorb it, and thence undergoes a further chemical proceſs. Sugar and butter therefore are not ſo eaſily digeſted, when taken in large quantity, as thoſe things, which contain leſs nutriment; hence, where the ſtomach is weak, they muſt be uſed in leſs quantity. But the cuſtom of ſome people in reſtraining children entirely from them, is depriving them of a very wholeſome, agreeable, and ſubſtantial part of their diet. Honey, manna, ſap-juice, are different kinds of leſs pure ſugar.

3. All the eſculent vegetables contain a bland oil, or mucilage, or ſtarch, or ſugar, or acid; and, as their ſtimulus is moderate, are properly given alone as food in inflammatory diſeaſes; and mixed with milk conſtitute the food of thouſands. Other vegetables poſſeſs various degrees and various kinds of ſtimulus; and to theſe we are beholden for the greater part of our Materia Medica, which produce nauſea, ſickneſs,

vomiting, catharſis, intoxication, inflammation, and even death, if unſkilfully adminiſtered.

The acrid or intoxicating, and other kinds of vegetable juices, ſuch as produce ſickneſs, or evacuate the bowels, or ſuch even as are only diſagreeable to the palate, appear to be a part of the defence of thoſe vegetables, which poſſeſs them, from the aſſaults of larger animals or of inſects. As mentioned in the Botanic Garden, Part II. Cant. I. line 161, note. This appears in a forcible manner from the peruſal of ſome travels, which have been publiſhed of thoſe unfortunate people, who have ſuffered ſhipwreck on uncultivated countries, and have with difficulty found food to ſubſiſt, in otherwiſe not inhoſpitable climates.

4. As theſe acrid and intoxicating juices generally reſide in the mucilage, and not in the ſtarch of many roots, and ſeeds, according to the obſervation of M. Parmentier, the wholeſome or nutritive parts of ſome vegetables may be thus ſeparated from the medicinal parts of them. Thus if the root of white briony be raſped into cold water, by means of a bread-grater made of a tinned iron plate, and agitated in it, the acrid juice of the root along with the mucilage will be diſſolved, or ſwim, in the water; while a ſtarch perfectly wholeſome and nutritious will

ſubſide, and may be uſed as food in times of ſcarcity.

M. Parmentier further obſerves, that potatoes contain too much mucilage in proportion to their ſtarch, which prevents them from being converted into good bread. But that if the ſtarch be collected from ten pounds of raw potatoes by grating them into cold water, and agitating them, as above mentioned; and if the ſtarch thus procured be mixed with other ten pounds of boiled potatoes, and properly ſubjected to fermentation like wheat flour, that it will make as good bread as the fineſt wheat.

Good bread may alſo be made by mixing wheat-flour with boiled potatoes. Eighteen pounds of wheat-flour are ſaid to make twenty-two pounds and a half of bread. Eighteen pounds of wheat-flour mixed with nine pounds of boiled potatoes, are ſaid to make twenty-nine pounds and a half of bread. This difference of weight muſt ariſe from the difference of the previous dryneſs of the two materials. The potatoes might probably make better flour, if they were boiled in ſteam, in a cloſe veſſel, made ſome degrees hotter than common boiling water.

Other vegetable matters may be deprived of their too great acrimony by boiling in water, as the great variety of the cabbage, the young tops of white briony, water-creſſes, aſparagus, with innumerable roots, and ſome fruits. Other plants have their acrid juices or bitter particles diminiſhed by covering them from the light by what is termed blanching them, as the ſtems and leaves of cellery, endive, ſea-kale. The former method either extracts or decompoſes the acrid particles, and the latter prevents them from being formed. See Botanic Garden, Vol. I. additional note XXXIV. on the Etiolation of vegetables.

5. The art of cookery, by expoſing vegetable and animal ſubſtances to heat, has contributed to increaſe the quantity of the food of mankind by other means beſides that of deſtroying their acrimony. One of theſe is by converting the acerb juices of ſome fruits into ſugar, as in the baking of unripe pears, and the bruiſing of unripe apples; in both which ſituations the life of the vegetable is deſtroyed, and the converſion of the harſh juice into a ſweet one muſt be performed by a chemical proceſs; and not by a vegetable one only, as the germination of barley in making malt has generally been ſuppoſed.

Some circumſtances, which ſeem to injure the life of ſeveral fruits, ſeem to forward the ſaccharine proceſs of their juices. Thus if ſome kinds of pears are gathered a week before they would ripen on the tree, and are laid on a heap and covered, their juice becomes ſweet many days ſooner. The taking off a circular piece of the bark from a branch of a pear-tree cauſes the fruit of that branch to ripen ſooner by a fortnight, as I have more than once obſerved. The wounds made in apples by inſects occaſion thoſe apples to ripen ſooner; caprification, or the piercing of figs, in the iſland of Malta, is ſaid to ripen them ſooner; and I am well informed, that, when bunches of grapes in this country have acquired their expected ſize, if the ſtalk of each bunch be cut half through, they will ſooner ripen.

The germinating barley in the malt-houſe I believe acquires little ſweetneſs, till the life of the ſeed is deſtroyed, and the ſaccharine proceſs then continued or advanced by the heat in drying it. Thus in animal digeſtion, the ſugar produced in the ſtomach is abſorbed by the lacteals as faſt as it is made, otherwiſe it ferments, and produces flatulency; ſo in the germination of barley in the malt-houſe, ſo long as the new plant lives, the ſugar, I ſuppoſe, is abſorbed as faſt as it is made; but that, which we uſe in making beer, is the ſugar produced by a chemical proceſs after the death of the young plant, or which is made more expeditiouſly, than the plant can abſorb it.

It is probably this ſaccharine proceſs, which obtains in new hayſtacks too haſtily, and which by immediately running into fermentation produces ſo much heat as to ſet them on fire. The greateſt part of the grain, or ſeeds, or roots, uſed in the diſtilleries, as wheat, canary ſeed, potatoes, are not I believe previouſly ſubjected to germination, but are in part by a chemical proceſs converted into ſugar, and immediately ſubjected to vinous fermentation; and it is probable a proceſs may ſometime be diſcovered of producing ſugar from ſtarch or meal; and of ſeparating it from them for domeſtic purpoſes by alcohol, which diſſolves ſugar but not mucilage; or by other means.

Another method of increaſing the nutriment of mankind by cookery, is by diſſolving cartilages and bones, and tendons, and probably ſome vegetables, in ſteam or water at a much higher degree of heat than that of boiling. This is to be done in a cloſe veſſel, which is called Papin's digeſter; in which, it is ſaid, that water may be made red-hot, and will then diſſolve all animal ſubſtances; and might thus add to our quantity of food in times of ſcarcity. This veſſel ſhould be made of iron, and ſhould have an oval opening at top, with an oval lid of iron larger than the aperture; this lid ſhould be ſlipped in endways, when the veſſel is filled, and then turned, and raiſed by a ſcrew above it into contact with the under edges of the aperture. There ſhould alſo be a ſmall tube or hole covered with a weighted valve to prevent the danger of burſting the digeſter.

Where the powers of digeſtion are weakened, broths made by boiling animal and vegetable ſubſtances in water afford a nutriment; though I ſuppoſe not ſo great as the fleſh and vegetables would afford, if taken in their ſolid form, and mixed with ſaliva in the act of maſtication. The aliment thus prepared ſhould be boiled but a ſhort time, nor ſhould be ſuffered to continue in our common kitchen-utenſils afterwards, as they are lined with a mixture of half lead and half tin, and are therefore unwholeſome, though the copper is completely covered. And thoſe ſoups, which have any acid or wine boiled in them, unleſs they be made in ſilver, or in china, or in thoſe pot-veſſels, which are not glazed by the addition of lead, are truly poiſonous; as the acid, as lemon-juice or vinegar, when made hot, erodes or diſſolves the lead and tin lining of the copper-veſſels, and the leaden glaze of the porcelain ones. Hence, where ſilver cannot be had, iron veſſels are preferable to tinned copper ones; or thoſe made of tinned iron-plates in the common tin-ſhops, which are ſaid to be covered with pure or block tin.

6. Another circumſtance, which facilitates the nouriſhment of mankind, is the mechanic art of grinding farinaceous ſeeds into powder between mill-ſtones; which may be called the artificial teeth of ſociety. It is probable, that ſome ſoft kinds of wood, eſpecially when they have undergone a kind of fermentation, and become of

looſer texture, might be thus uſed as food in times of famine.

Nor is it improbable, that hay, which has been kept in ſtacks, ſo as to undergo the ſaccharine proceſs, may be ſo managed by grinding and by fermentation with yeaſt like bread, as to ſerve in part for the ſuſtenance of mankind in times of great ſcarcity. Dr. Prieſtley gave to a cow for ſome time a ſtrong infuſion of hay in large quantity for her drink, and found that ſhe produced during this treatment above double the quantity of milk. Hence if bread cannot be made from ground hay, there is great reaſon to ſuſpect, that a nutritive beverage may be thus prepared either in its ſaccharine ſtate, or fermented into a kin of beer.

In times of great ſcarcity there are other vegetables, which though not in common uſe, would moſt probably afford wholeſome nouriſhment, either by boiling them, or drying and grinding them, or by both thoſe proceſſes in ſucceſſion. Of theſe are perhaps the tops and the bark of all thoſe vegetables, which are armed with thorns or prickles, as gooſeberry trees, holly, gorſe, and perhaps hawthorn. The inner bark of the elm tree makes a kind of gruel. And the roots of fern, and probably of very many other roots, as of graſs and of clover taken up in winter, might yield nouriſhment either by boiling or baking, and ſeparating the fibres from the pulp by beating

ing them; or by getting only the ſtarch from thoſe, which poſſeſs an acrid mucilage, as the white briony. And the alburnum of perhaps all trees, and eſpecially of thoſe which bleed in ſpring, might produce a ſaccharine and mucilaginous liquor by boiling it in the winter or ſpring.

7. However the arts of cookery and of grinding may increaſe or facilitate the nouriſhment of mankind, the great ſource of it is from agriculture. In the ſavage ſtate, where men live ſolely by hunting, I was informed by Dr. Franklin, that there was ſeldom more than one family exiſted in a circle of five miles diameter; which in a ſtate of paſturage would ſupport ſome hundred people, and in a ſtate of agriculture many thouſands. The art of feeding mankind on ſo ſmall a grain as wheat, which ſeems to have been diſcovered in Egypt by the immortal name of Ceres, ſhewed greater ingenuity than feeding them with the large roots of potatoes, which ſeem to have been a diſcovery of ill-fated Mexico.

This greater production of food by agriculture than by paſturage, ſhews that a nation nouriſhed by animal food will be leſs numerous than if nouriſhed by vegetable; and the former will therefore be liable, if they are engaged in war, to be conquered by the latter, as Abel was ſlain by Cain. This is perhaps the only valid argument againſt incloſing open arable fields. The great production of human nouriſhment by agriculture and paſturage evinces the advantage of ſociety over the ſavage ſtate; as the number of mankind becomes increaſed a thouſand fold by the arts of agriculture and paſturage; and their happineſs is probably under good governments improved in as great a proportion, as they become liberated from the hourly fear of beaſts of prey, from the daily fear of famine, and of the occaſional incurſions of their cannibal neighbours.

But paſturage cannot exiſt without property both in the ſoil, and the herds which it nurtures; and for the invention of arts, and production of tools neceſſary to agriculture, ſome muſt think, and others labour; and as the efforts of ſome will be crowned with greater ſucceſs than that of others, an inequality of the ranks of ſociety muſt ſucceed; but this inequality of mankind in the preſent ſtate of the world is too great for the purpoſes of producing the greateſt quantity of human nouriſhment, and the greateſt ſum of human happineſs; there ſhould be no ſlavery at one end of the chain of ſociety, and no deſpotiſm at the other.—By the future improvements of human reaſon ſuch governments may poſſibly hereafter be eſtabliſhed, as may a hundred-fold increaſe the numbers of mankind, and a thouſand-fold their happineſs.

IV. 1. Water

IV. 1. Water muſt be conſidered as a part of our nutriment, becauſe ſo much of it enters the compoſition of our ſolids as well as of our fluids; and becauſe vegetables are now believed to draw almoſt the whole of their nouriſhment from this ſource. As in them the water is decompoſed, as it is perſpired by them in the ſunſhine, the oxygen gas increaſes the quantity and the purity of the atmoſphere in their vicinity, and the hydrogen ſeems to be retained, and to form the nutritive juices, and conſequent ſecretions of reſin, gum, wax, honey, oil, and other vegetable productions. See Botanic Garden, Part I. Cant. IV. line 25, note. It has however other uſes in the ſyſtem, beſides that of a nouriſhing material, as it dilutes our fluids, and lubricates our ſolids; and on all theſe accounts a daily ſupply of it is required.

2. River-water is in general purer than ſpring-water; as the neutral ſalts waſhed down from the earth decompoſe each other, except perhaps the marine ſalt; and the earths, with which ſpring-water frequently abounds, is precipitated; yet it is not improbable, that the calcareous earth diſſolved in the water of many ſprings may contribute to our nouriſhment, as the water from ſprings, which contain earth, is ſaid to conduce to enrich thoſe lands, which are flooded with it, more than river water.

The Chineſe are ſaid, by Sir G. Staunton, to purify the water of ſome muddy rivers or canals, by ſtirring them with a hollow cane full of ſmall holes, in the tube of which are encloſed ſome pieces of alum. And the bakers in London aſſert, that one uſe of alum is to clear the New River water, and thus to render their bread whiter. Where any volatile alcali is mixed with water, as often happens from the ſtable dung and other ordure of populous towns, it will be converted to vitriolic ammoniac by a ſolution of alum; and calcareous earth may be converted into gypſum, and ſubſide along with the earth of the alum. See Claſs II. 1. 6. 16.

3. Many arguments ſeem to ſhew, that calcareous earth contributes to the nouriſhment of animals and vegetables. Firſt becauſe calcareous earth conſtitutes a conſiderable part of them, and muſt therefore either be received from without, or formed by them, or both, as milk, when taken as food by a lacteſcent woman, is decompoſed in the ſtomach by the proceſs of digeſtion, and again in part converted into milk by the pectoral glands. Secondly, becauſe from the analogy of all organic life, whatever has compoſed a part of a vegetable or animal may again after its chemical ſolution become a part of another vegetable or animal, ſuch is the general tranſmigration of matter. And thirdly, becauſe the great

uſe of lime in agriculture on almoſt all kinds of ſoil and ſituation cannot be ſatisfactorily explained from its chemical properties alone. Though theſe may alſo in certain ſoils and ſituations have conſiderable effect.

The chemical uſes of lime in agriculture may be, 1. from its deſtroying in a ſhort time the coheſion of dead vegetable fibres, and thus reducing them to earth, which otherwiſe is effected by a ſlow proceſs either by the conſumption of inſects or by a gradual putrefaction. Thus I am informed that a mixture of lime with oak bark, after the tanner has extracted from it whatever is ſoluble in water, will in two or three months reduce it to a fine black earth, which, if only laid in heaps, it would require as many years to effect by its own ſpontaneous fermentation or putrefaction. This effect of lime muſt be particularly advantageous to newly encloſed commons when firſt broken up.

Secondly, lime for many months continues to attract moiſture from the air or earth, which it deprives I ſuppoſe of carbonic acid, and then ſuffers it to exhale again, as is ſeen on the plaſtered walls of new houſes. On this account it muſt be advantageous when mixed with dry or ſandy ſoils, as it attracts moiſture from the air above or the earth beneath, and this moiſture is then abſorbed by the lymphatics of the roots of vegetables. Thirdly, by mixing lime with clays

it

it is believed to make them leſs coheſive, and thus to admit of their being more eaſily penetrated by vegetable fibres. A mixture of lime with clays deſtroys their ſuperabundancy of acid, if ſuch exiſts, and by uniting with it converts it into gypſum or alabaſter. And laſtly, freſh lime deſtroys worms, ſnails, and other inſects, with which it happens to come in contact.

Yet do not all theſe chemical properties ſeem to account for the great uſes of lime in almoſt all ſoils and ſituations, as it contributes ſo much to the melioration of the crops, as well as to their increaſe in quantity. Wheat from land well limed is believed by farmers, millers, and bakers, to be, as they ſuppoſe, thinner ſkinned; that is, it turns out more and better flour; which I ſuppoſe is owing to its containing more ſtarch and leſs mucilage. In reſpect to graſs-ground I am informed, that if a ſpadeful of lime be thrown on a tuſſock, which horſes or cattle have refuſed to touch for years, they will for many ſucceeding ſeaſons eat it quite cloſe to the ground.

One property of lime is not perhaps yet well underſtood, I mean its producing ſo much heat, when it is mixed with water; which may be owing to the elementary fluid of heat conſolidated in the lime. It is the ſteam occaſioned by this heat, when water is ſprinkled upon lime, if the water be not in too great quantity or too cold, which breaks the lime into ſuch fine powder as almoſt to become fluid, which cannot be effected perhaps by any other means, and which I ſuppoſe muſt give great preference to lime in agriculture, and to the ſolutions of calcareous earth in water, over chalk or powdered lime-ſtone, when ſpread upon the land.

4. It was formerly believed that waters replete with calcareous earth, ſuch as incruſt the inſide of tea-kettles, or are ſaid to petrify moſs, were liable to produce or to increaſe the ſtone in the bladder. This miſtaken idea has lately been exploded by the improved chemiſtry, as no calcareous earth, or a very minute quantity, was found in the calculi analyſed by Scheele and Bergman. The waters of Matlock and of Carlſbad, both which cover the moſs, which they paſs through, with a calcareous cruſt, are ſo far from increaſing the ſtone of the bladder or kidneys, that thoſe of Carlſbad are celebrated for giving relief to thoſe labouring under theſe diſeaſes. Philoſ. Tranſ. Thoſe of Matlock are drunk in great quantities without any ſuſpicion of injury; and I well know a perſon who for above ten years has drunk about two pints a day of cold water from a ſpring, which very much incruſts the veſſels, it is boiled in, with calcareous earth, and affords a copious calcareous ſediment with a ſolution of ſalt of tartar, and who enjoys a ſtate of uninterrupted health.

V. 1. As animal bodies conſiſt much both of oxygen and azote, which make up the compoſition of atmoſpheric air, theſe ſhould be counted amongſt nutritious ſubſtances. Beſides that by the experiments of Dr. Prieſtley it appears, that the oxygen gains admittance into the blood through the moiſt membranes of the lungs; and ſeems to be of much more immediate conſequence to the preſervation of our lives than the other kinds of nutriment above ſpecified.

As the baſis of fixed air, or carbonic acid gas, is carbone, which alſo conſtitutes a great part both of vegetable and animal bodies; this air ſhould likewiſe be reckoned amongſt nutritive ſubſtances. Add to this, that when this carbonic acid air is ſwallowed, as it eſcapes from beer or cyder, or when water is charged with it as detruded from limeſtone by vitriolic acid, it affords an agreeable ſenſation both to the palate and ſtomach, and is therefore probably nutritive.

The immenſe quantity of carbone and of oxygen which conſtitute ſo great a part of the limeſtone countries is almoſt beyond conception, and, as it has been formed by animals, may again become a part of them, as well as the calcareous matter with which they are united. Whence it may be conceived, that the waters, which abound with limeſtone in ſolution, may ſupply nutriment both to animals and to vegetables, as mentioned above.

VI. 1. The

VI. 1. The manner, in which nutritious particles are ſubſtituted in the place of thoſe, which are mechanically abraded, or chemically decompoſed, or which vaniſh by animal abſorption, muſt be owing to animal appetency, as deſcribed in Sect. XXXVII. 3. and is probably ſimilar to the proceſs of inflammation, which produces new veſſels and new fluids; or to that which conſtitutes the growth of the body to maturity. Thus the granulations of new fleſh to repair the injuries of wounds are viſible to the eye; as well as the callous matter, which cements broken bones; the calcareous matter, which repairs injured ſnail-ſhells; and the threads, which are formed by ſilk-worms and ſpiders; which are all ſecreted in a ſofter ſtate, and harden by exſiccation, or by the contact of the air, or by abſorption of their more fluid parts.

Whether the materials, which thus ſupply the waſte of the ſyſtem, can be given any other way than by the ſtomach, ſo as to preſerve the body for a length of time, is worth our inquiry; as caſes ſometimes occur, in which food cannot be introduced into the ſtomach, as in obſtructions of the œſophagus, inflammations of the throat, or in hydrophobia; and other caſes are not unfrequent in which the power of digeſtion is nearly or totally deſtroyed, as in anorexia epileptica, and in many fevers.

In the former of theſe circumſtances liquid nutriment may ſometimes be gotten into the ſtomach through a flexible catheter; as deſcribed in Claſs III. 1. 1. 15. In the latter many kinds of mild aliment, as milk or broth, have frequently been injected as clyſters, together with a ſmall quantity of opium, as ten drops of the tincture, three or four times a day; to which alſo might be added very ſmall quantities of vinous ſpirit. But theſe, as far as I have obſerved, will not long ſuſtain a perſon, who cannot take any ſuſtenance by the ſtomach.

2. Another mode of applying nutritive fluids might be by extenſive fomentations, or by immerging the whole body in a bath of broth, or of warm milk, which might at the ſame time be coagulated by rennet, or the acid of the calf's ſtomach; broth or whey might thus probably be introduced, in part at leaſt, into the circulation, as a ſolution of nitre is ſaid to have been abſorbed in a pediluvium, which was afterwards diſcovered by the manner in which paper dipped frequently in the urine of the patient and dried, burnt and ſparkled like touch-paper. Great quantity of water is alſo known to be abſorbed by thoſe, who have bathed in the warm bath after exerciſe and abſtinence from liquids. Cleopatra was ſaid to travel with 4000 milch-aſſes in her train, and to bathe every morning in their milk, which ſhe probably might uſe as a coſmetic rather than a nutritive.

3. The transfuſion of blood from another animal into the vein of one, who could take no ſuſtenance by the throat, or digeſt none by the ſtomach, might long continue to ſupport him; and perhaps other nutriment, as milk or mucilage, might be this way introduced into the ſyſtem, but we have not yet ſufficient experiments on this ſubject. See Sect. XXXII. 4. and Claſs I. 2. 3. 25. and Sup. I, 14. 2.

VII. Various kinds of condiments, or ſauces, have been taken along with vegetable or animal food, and have been thought by ſome to ſtrengthen the proceſs of digeſtion and conſequent proceſs of nutrition. Of theſe wine, or other fermented liquors, vinegar, ſalt, ſpices, and muſtard, have been in moſt common uſe, and I believe to the injury of thouſands. As the ſtomach by their violent ſtimulus at length loſes its natural degree of irritability, and indigeſtion is the conſequence; which is attended with flatulency and emaciation. Where any of theſe have been taken ſo long as to induce a habit, they muſt either be continued, but not increaſed; or the uſe of them ſhould be gradually and cautiouſly diminiſhed or diſcontinued, as directed in Sect. XII. 7. 8.

III. Catalogue of the Nutrientia.

I. 1. Veniſon, beef, mutton, hare, gooſe, duck, woodcock, ſnipe, moor-game.

2. Oyſters, lobſters, crabs, ſhrimps, muſhrooms, eel, tench, barbolt, ſmelt, turbot, ſole, turtle.

3. Lamb, veal, ſucking-pig.

4. Turkey, partridge, pheaſant, ſowl, eggs.

5. Pike, perch, gudgeon, trout, grayling.

II. Milk, cream, butter, buttermilk, whey, cheeſe.

III. Wheat, barley, oats, peaſe, potatoes, turnips, carrots, cabbage, aſparagus, artichoke, ſpinach, beet, apple, pear, plum, apricot, nectarine, peach, ſtrawberry, grape, orange, melon, cucumber, dried figs, raiſins, ſugar, honey. With a great variety of other roots, ſeeds, leaves, and fruits.

IV. Water, river-water, ſpring-water, calcareous earth.

V. Air, oxygene, azote, carbonic acid gas.

VI. Nutritive baths and clyſters, transfuſion of blood.

VII. Condiments.

Art.

Art. II.

INCITANTIA.

I. 1. Thoſe things, which increaſe the exertions of all the irritative motions, are termed incitantia. As alcohol, or the ſpirituous part of fermented liquors, opium, and many drugs, which are ſtill eſteemed poiſons, their proper doſes not being aſcertained. To theſe ſhould be added the exhilarating paſſions of the mind, as joy, love: and externally the application of heat, electricity, ether, eſſential oils, friction, and exerciſe.

2. Theſe promote both the ſecretions and abſorptions, increaſe the natural heat, and remove thoſe pains, which originate from the defect of irritative motions, termed nervous pains; and prevent the convulſions conſequent to them. When given internally they induce coſtiveneſs, and deep coloured urine; and by a greater doſe intoxication, and its conſequences.

II. Observations on the Incitantia.

I. 1. Opium and alcohol increaſe all the ſecretions and abſorptions, The increaſe of the ſecretion of ſenſorial power appears from the violent exertions of drunken people; the ſecretion of ſweat is more certainly excited by opium or wine than by any other medicine; and the increaſe of general heat, which theſe drugs produce, is an evidence of their effect in promoting all the ſecretions; ſince an increaſe of ſecretion is always attended with increaſe of heat in the part, as in hepatic and other inflammations.

2. But as they at the ſame time promote abſorption; thoſe fluids, which are ſecreted into receptacles, as the urine, bile, inteſtinal and pulmonary mucus, have again their thinner parts abſorbed; and hence, though the quantity of ſecreted fluid was increaſed, yet as the abſorption was alſo increaſed, the excretion from theſe receptacles is leſſened; at the ſame time that it is deeper coloured or of thicker conſiſtence, as the urine, alvine feces, and pulmonary mucus. Whereas the perſpiration being ſecreted on the ſurface of the body is viſible in its increaſed quantity, before it can be reabſorbed; whence ariſes that erroneous opinion, that opium increaſes the cutaneous ſecretion, and leſſens all the others.

3. It muſt however be noted, that after evacuations opium ſeems to promote the abſorptions more than the ſecretions; if you except that of the ſenſorial power in the brain, which probably ſuffers no abſorption. Hence its efficacy in reſtraining hæmorrhages, after the veſſels are emptied, by promoting venous abſorption.

4. In ulcers the matter is thickened by the exhibition of opium from the increaſed abſorption of the thinner parts of it; but it is probable, that the whole ſecretion, including the part which is abſorbed, is increaſed; and hence new fibres are ſecreted along with the matter, and the ulcer fills with new granulations of fleſh. But as no ulcer can heal, till it ceaſes to diſcharge; that is, till the abſorption becomes as great as the excretion; thoſe medicines, which promote abſorption only, are more advantageous for the healing an ulcer after it is filled with new fleſh; as the Peruvian bark internally, with bandages and ſolutions of lead externally.

5. There are many pains which originate from a want of due motion in the part, as thoſe occaſioned by cold; and all thoſe pains which are attended with cold extremities, and are generally termed nervous. Theſe are relieved by whatever excites the part into its proper actions, and hence by opium and alcohol; which are the moſt univerſal ſtimulants we are acquainted with. In theſe caſes the effect of opium is produced, as ſoon as the body becomes generally warm; and a degree of intoxication or ſleep follows the ceſſation of the pain.

Theſe nervous pains (as they are called) frequently return at certain periods of time, and are alſo frequently ſucceeded by convulſions;

in theſe caſes if opium removes the pain, the convulſions do not come on. For this purpoſe it is beſt to exhibit it gradually, as a grain every hour, or half hour, till it intoxicates. Here it muſt be noted, that a much leſs quantity will prevent the periods of theſe cold pains, than is neceſſary to relieve them after their acceſs. As a grain and half of opium given an hour before the expected paroxyſm will prevent the cold fit of an intermittent fever, but will not ſoon remove it, when it is already formed. For in the former caſe the uſual or healthy aſſociations or catenations of motion ſavour the effect of the medicine; in the latter caſe theſe aſſociations or catenations are diſordered, or interrupted, and new ones are formed, which ſo far counteract the effect of the medicine.

When opium has been required in large doſes to eaſe or prevent convulſions, ſome have adviſed the patient to omit the uſe of wine, as a greater quantity of opium might then be exhibited; and as opium ſeems to increaſe abſorption more, and ſecretion leſs, than vinous ſpirit; it may in ſome caſes be uſeful to exchange one for the other; as in diſeaſes attended with too great evacuation, as diarrhœa, and dyſentery, opium may be preferable; on the contrary in tetanus, or locked-jaw, where inflammation of the ſyſtem might be of ſervice, wine may be preferable to opium; ſee Claſs III. 1. 1. 12. I have generally obſerved, that a mixture of ſpirit of wine and warm water, given alternately with the doſes of opium, has ſooneſt and moſt certainly produced that degree of intoxication, which was neceſſary to relieve the patient in the epilepſia dolorifica.

The external application of opium may alſo be uſed with advantage, and eſpecially when the ſtomach rejects its internal uſe; for this purpoſe I have directed the whole ſpine of the back to be moiſtened with tincture of opium with ſucceſs in epileptic convulſions. And an extenſive friction with a liniment conſiſting of ſix grains of opium, well triturated with an ounce of hog's fat, has lately been ſaid to induce ſleep in maniacal caſes, by Dr. L. Frank of Florence.

Injections of a ſolution or tincture of opium into the rectum act on the general conſtitution, but require about double the quantity for that purpoſe as when taken into the ſtomach. Injections of a ſolution of opium into the urethra may be of ſervice to relieve pain, or to produce the abſorption of the new veſſels produced by inflammation, after ſufficient evacuations, as is ſeen when it is applied to an inflamed eye. Or laſtly, to alleviate the pain from acrid diſcharges by increaſing their abſorption, or the pain from torpor of the part, as in ſome tooth-achs, by its external application.

6. There is likewiſe ſome relief given by opi-

um to inflammatory pains, or thoſe from exceſs of motion in the affected part; but with this difference, that this relief from the pains, and the ſleep, which it occaſions, do not occur till ſome hours after the exhibition of the opium. This requires to be explained; after the ſtimulus of opium or of alcohol ceaſes, as after common drunkenneſs, a conſequent torpor comes on; and the whole habit becomes leſs irritable by the natural ſtimuli. Hence the head-achs, ſickneſs, and languor, on the next day after intoxication, with cold ſkin, and general debility. Now in pains from exceſs of motion, called inflammatory pains, when opium is given, the pain is not relieved, till the debility comes on after the ſtimulus ceaſes to act; for then after the greater ſtimulus of the opium has exhauſted much of the ſenſorial power, the leſs ſtimulus, which before cauſed the pain, does not now excite the part into unnatural action.

In theſe caſes the ſtimulus of the opium firſt increaſes the pain; and it ſometimes happens, that ſo great a torpor follows, as to produce the death or mortification of the affected part; whence the danger of giving opium in inflammatory diſeaſes, eſpecially in inflammation of the bowels; but in general the pain returns with its former violence, when the torpor above mentioned ceaſes. Hence theſe pains attended with inflammation are beſt relieved by copious veneſection, other evacuations, and the claſs of medicines called torpentia.

7. Theſe pains from exceſs of motion are attended with increaſed heat of the whole, or of the affected part, and a ſtrong quick pulſe; the pains from defect of motion are attended with cold extremities, and a weak pulſe; which is alſo generally more frequent than natural, but not always ſo.

8. Opium and alcohol are the only two drugs, we are much acquainted with, which intoxicate; and by this circumſtance are eaſily diſtinguiſhed from the ſecernentia and ſorbentia. Camphor, and cicuta, and nicotiana, are thought to induce a kind of intoxication; and there are many other drugs of this claſs, whoſe effects are leſs known, or their doſes not aſcertained; as atropa belladonna, hyoſcyamus, ſtramonium, prunus lauroceraſus, meniſpermum, cynogloſſum, ſome fungi, and the water diſtilled from black cherry-ſtones; the laſt of which was once much in uſe for the convulſions of children, and was ſaid to have good effect; but is now improvidently left out of our pharmacopœias. I have known one leaf of the lauroceraſus, ſhred and made into tea, given every morning for a week with no ill conſequence to a weak hyſteric lady, but rather perhaps with advantage.

It is probable, that other bitter kernels, as thoſe of horſe-cheſnuts, and of acorns, æſculus hippocaſtanum, and quercus robur, may poſſeſs ſomewhat of an intoxicating quality; and by this kind of ſtimulus, as well as by their bitter part, may be uſed to prevent the paroxyſm of an ague, if adminiſtered an hour before the expected acceſs of it, as is lately affirmed by Dr. Fuchs of Jena; who ſays, an extract prepared from the ripe kernels of the horſe-cheſnut acts like an extract of Peruvian bark; and adds that the bark alſo of this tree is uſed with ſucceſs inſtead of the Peruvian bark.

9. The pernicious effects of a continued uſe of much vinous ſpirit is daily ſeen and lamented by phyſicians; not only early debility, like premature age, but a dreadful catalogue of diſeaſes is induced by this kind of intemperance; as dropſy, gout, leproſy, epilepſy, inſanity, as deſcribed in Botanic Garden, Part II. Canto III. line 357. The ſtronger or leſs diluted the ſpirit is taken, the ſooner it ſeems to deſtroy, as in dram-drinkers; but ſtill ſooner, when kernels of apricots, or bitter almonds, or laurel-leaf, are infuſed in the ſpirit, which is termed ratafia; as then two poiſons are ſwallowed at the ſame time. And vinegar, as it contains much vinous ſpirit, is probably a noxious part of our diet. And the diſtilled vinegar, which is commonly ſold in the

ſhops, is truly poiſonous, as it is generally diſtilled by means of a pewter or leaden alembic-head or worm-tube, and abounds with lead; which any one may detect by mixing with it a ſolution of liver of ſulphur. Opium, when taken as a luxury, not as a medicine, is as pernicious as alcohol; as Baron de Tott relates in his account of the opium-eaters in Turkey.

10. It muſt be obſerved, that a frequent repetition of the uſe of this claſs of medicines ſo habituates the body to their ſtimulus, that their doſe may gradually be increaſed to an aſtoniſhing quantity, ſuch as otherwiſe would inſtantly deſtroy life; as is frequently ſeen in thoſe, who accuſtom themſelves to the daily uſe of alcohol and opium; and it would ſeem, that theſe unfortunate people become diſeaſed as ſoon as they omit their uſual potations; and that the conſequent gout, dropſy, palſy, or pimpled face, occur from the debility occaſioned from the want of accuſtomed ſtimulus, or to ſome change in the contractile fibres, which requires the continuance or increaſe of it. Whence the cautions neceſſary to be obſerved are mentioned in Sect. XII. 7. 8.

11. It is probable, that ſome of the articles in the ſubſequent catalogue do not induce intoxication, though they have been eſteemed to do

ſo; as tobacco, hemlock, nux vomica, ſtaviſagria; and on this account ſhould rather belong to other arrangements, as to the ſecernentia, or ſorbentia, or invertentia.

II. 1. Externally the application of heat, as the warm bath, by its ſtimulus on the ſkin excites the excretory ducts of the perſpirative glands, and the mouths of the lymphatics, which open on its ſurface, into greater action; and in conſequence many other irritative motions, which are aſſociated with them. To this increaſed action is added pleaſurable ſenſation, which adds further activity to the ſyſtem; and thus many kinds of pain receive relief from this additional atmoſphere of heat.

The uſe of a warm bath of about 96 or 98 degrees of heat, for half an hour once a day for three or four months, I have known of great ſervice to weak people, and is perhaps the leaſt noxious of all unnatural ſtimuli; which however, like all other great excitement, may be carried to exceſs, as complained of by the ancients. The unmeaning application of the words relaxation and bracing to warm and cold baths has much prevented the uſe of this grateful ſtimulus; and the miſuſe of the term warm-bath, when applied to baths colder than the body, as to thoſe of Buxton and Matlock, and to artificial baths of leſs than 90 degrees of heat, which ought to be termed cold ones, has contributed to miſlead the unwary in their application.

The ſtimulus of wine, or ſpice, or ſalt, increaſes the heat of the ſyſtem by increaſing all or ſome of the ſecretions; and hence the ſtrength is diminiſhed afterwards by the loſs of fluids, as well as by the increaſed action of the fibres. But the ſtimulus of the warm-bath ſupplies heat rather than produces it; and rather fills the ſyſtem by increaſed abſorption, than empties it by increaſed ſecretion; and may hence be employed with advantage in almoſt all caſes of debility with cold extremities, perhaps even in anaſarca, and at the approach of death in fevers. In theſe caſes a bath much beneath 98 degrees, as of 80 or 85, might do injury, as being a cold-bath compared with the heat of the body, though ſuch a bath is generally called a warm one.

The activity of the ſyſtem thus produced by a bath of 98 degrees of heat, or upwards, does not ſeem to render the patients liable to take cold, when they come out of it; for the ſyſtem is leſs inclined to become torpid than before, as the warmth thus acquired by communication, rather than by increaſed action, continues long without any conſequent chillneſs. Which accords with the obſervation of Dr. Fordyce, mentioned in Sup. I. 5. 1. who ſays, that thoſe who are confined ſome time in an atmoſphere of 120 or 130 degrees of heat, do not feel cold or look pale on coming into a temperature of 30 or 40 degrees; which would produce great paleneſs and ſenſation of coldneſs in thoſe, who had been ſome time confined in an atmoſphere of only 86 or 90 degrees of heat. Treatiſe on Simple Fever, p. 168.

Hence heat, where it can be confined on a torpid part along with moiſture, as on a ſcrofulous tumour, will contribute to produce ſuppuration or reſolution. This is done by applying a warm poultice, which ſhould be frequently repeated; or a plaſter of reſin, wax, or fat; or by covering the part with oiled ſilk; both which laſt prevent the perſpirable matter from eſcaping as well as the heat of the part, as theſe ſubſtances repel moiſture, and are bad conductors of heat. Another great uſe of the ſtimulus of heat is by applying it to torpid ulcers, which are generally termed ſcrofulous or ſcorbutic, and are much eaſier inclined to heal, when covered with ſeveral folds of flannel.

Mr. —— had for many months been afflicted with an ulcer in perinæo, which communicated with the urethra, through which a part of his urine was daily evacuated with conſiderable pain; and was reduced to a great degree of debility. He uſed a hot-bath of 96 or 98 degrees of heat every day for half an hour during about ſix months. By this agreeable ſtimulus repeated thus at uniform

form times not only the ulcer healed, contrary to the expectation of his friends, but he acquired greater health and ſtrength, than he had for ſome years previouſly experienced.

Mrs. —— was affected with tranſient pains, which were called nervous ſpaſms, and with great fear of diſeaſes which ſhe did not labour under, with cold extremities, and general debility. She uſed a hot-bath every other day of 96 degrees of heat for about four months, and recovered a good ſtate of health, with greater ſtrength and courage, than ſhe had poſſeſſed for many months before.

Mr. Z. a gentleman about 65 years of age, had lived rather intemperately in reſpect to vinous potation, and had for many years had annual viſits of the gout, which now became irregular, and he appeared to be loſing his ſtrength, and beginning to feel the effects of age. He uſed a bath, as hot as was agreeable to his ſenſations, twice a week for about a year and half, and greatly recovered his health and ſtrength with leſs frequent and leſs violent returns of regular gout, and is now near 80 years of age.

When Dr. Franklin, the American philoſopher, was in England many years ago, I recommended to him the uſe of a warm-bath twice a week to prevent the too ſpeedy acceſs of old age, which he then thought that he felt the approach of, and I have been informed, that he continued the uſe of it till near his death, which was at an advanced age.

All theſe patients were adviſed not to keep themſelves warmer than their uſual habits, after they came out of the bath, whether they went into bed or not; as the deſign was not to promote perſpiration, which weakens all conſtitutions, and ſeldom is of ſervice to any. Thus a flannel ſhirt, particularly if it be worn in warm weather, occaſions weakneſs by ſtimulating the ſkin by its points into too great action, and producing heat in conſequence; and occaſions emaciation by increaſing the diſcharge of perſpirable matter; and in both theſe reſpects differs from the effect of warm bathing, which communicates heat to the ſyſtem at the ſame time that it ſtimulates it, and cauſes abſorption more than exhalation.

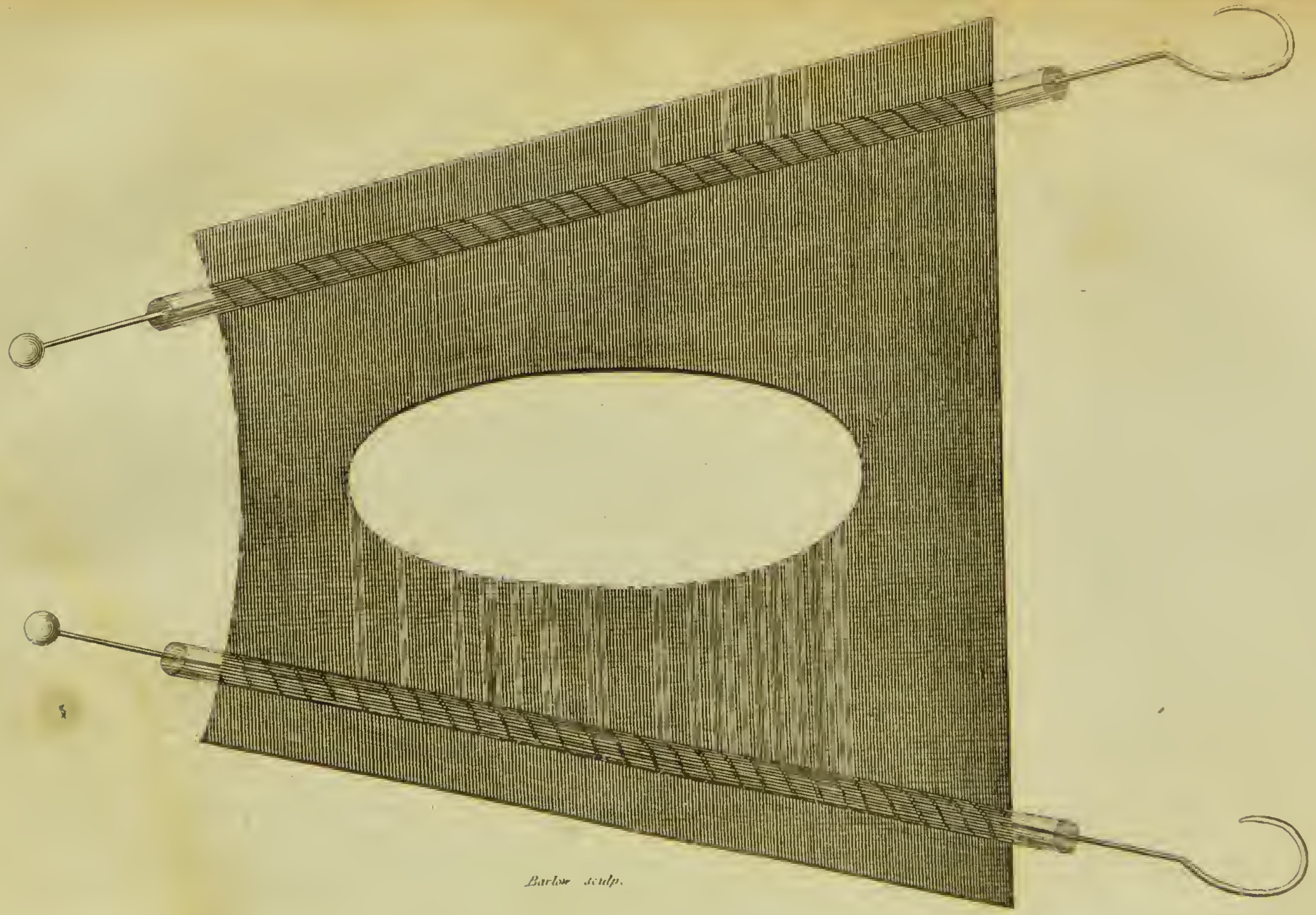
Thoſe who have remained half an hour in a warm bath, when they have previouſly been exhauſted by exerciſe, or abſtinence from food or fluids, have abſorbed ſo much as to increaſe their weight conſiderably. Dr. Jurin found an increaſe of weight to 18 ounces by ſleeping in a cool room after a day's exerciſe and abſtinence, ſo much in that ſituation was abſorbed from the atmoſphere. But it has lately been obſerved by Dr. Rollo and by Dr. Currie, that ſome patients did not weigh heavier after coming out of the warm-bath, and being wiped dry. From whence we may conclude, that theſe patients were not previouſly in a ſtate of inannition; or that they had remained ſo long in the bath as to loſe ſomewhat by the perpetual waſte of the ſyſtem by digeſtion, circulation, and ſecretion. And certainly as no waſte occurs by the uſe of the warm-bath, this muſt be the moſt harmleſs, conſequently the moſt ſalutary of all increaſed ſtimuli. See Claſs I. 1. 2. 3.

2. The effect of the paſſage of an electric ſhock through a paralytic limb in cauſing it to contract, beſides the late experiments of Galvani and Volta on frogs, entitle it to be claſſed amongſt univerſal ſtimulants. Electric ſhocks frequently repeated daily for a week or two remove chronical pains, as the pleurodyne chronica, Claſs I. 2. 4. 14. and other chronic pains, which are termed rheumatic, probably by promoting the abſorption of ſome extravaſated material. Scrofulous tumours are ſometimes abſorbed, and ſometimes brought to ſuppurate by paſſing electric ſhocks through them daily for two or three weeks.

Miſs ——, a young lady about eight years of age, had a ſwelling about the ſize of a pigeon's egg on her neck a little below her ear, which long continued in an indolent ſtate. Thirty or forty ſmall electric ſhocks were paſſed through it once or twice a day for two or three weeks, and it then ſuppurated and healed without difficulty.

For this operation the coated jar of the electric machine had on its top an electrometer, which meaſured the ſhocks by the approach of a braſs knob, which communicated with the external coating to another, which communicated with the internal one, and their diſtance was adjuſted by a ſcrew. So that the ſhocks were ſo ſmall as not to alarm the child, and the accumulated electricity was frequently diſcharged as the wheel continued turning. The tumour was encloſed between two other braſs knobs, which were fixed on wires, which paſſed through glaſs tubes; the tubes were cemented in two grooves on a board, ſo that at one end they were nearer each other than at the other, and the knobs were puſhed out ſo far as exactly to include the tumour, as deſcribed in the annexed plate, which is about half the ſize of the original apparatus.

Inflammations of the eyes without fever are frequently cured by taking a ſtream of very ſmall electric ſparks from them, or giving the electric ſparks to them, once or twice a day for a week or two; that is, the new veſſels, which conſtitute inflammation in theſe inirritable conſtitutions, are abſorbed by the activity of the abſorbents induced by the ſtimulus of the electric aura. For this operation the eaſieſt method is to fix a pointed wire to a ſtick of ſealing wax, or to an inſulating handle of glaſs; one end of this wire



Barlow sculp.

communicates with the prime conductor, and the point is approached near the inflamed eye in every direction.

III. Externally the application of ether, and of eſſential oils, as of cloves or cinnamon, ſeems to poſſeſs a general ſtimulating effect. As they inſtantly relieve tooth-ach, and hiccough, when theſe pains are not in violent degree; and camphor in large doſes is ſaid to produce intoxication; this effect however I have not been witneſs to, and have reaſon to doubt.

Ether dropped into the ears of ſome deafiſh people, ſeems to poſſeſs a two-fold effect, one of diſſolving the indurated ear-wax, and the other of ſtimulating the torpid organ, but it is liable to give ſome degree of pain, unleſs it be freed from the ſulphurous acid, ſome of which ariſes along with it in diſtillation; to purify it from this material it ſhould be rectified from manganeſe. See Claſs I. 2. 5. 6. Lime added to impure ether may alſo unite with the ſulphuric acid, if ſuch exiſts in it, and form ſelenite, and ſubſide.

The manner in which ether and the eſſential oil operate on the ſyſtem when applied externally, is a curious queſtion, as pain is ſo immediately relieved by them, that they muſt ſeem to penetrate by the great fluidity or expanſive property of a part of them, as of their odoriferous exhalation or vapour, and thus ſtimulate

late the torpid part, and not by their being taken up by the abſorbent veſſels, and carried thither by the long courſe of circulation; nor is it probable, that theſe pains are relieved by the ſympathy of the torpid membrane with the external ſkin, which is thus ſtimulated into action; as it does not ſucceed, unleſs it is applied over the pained part. Thus there appears to be three different modes by which extraneous bodies may be introduced into the ſyſtem, beſides that of abſorption. 1ſt. By ethereal tranſition, as heat and electricity; 2d. by chemical attraction, as oxygen; and 3d. by expanſive vapour, as ether and eſſential oils.

IV. The perpetual neceſſity of the mixture of oxygen gas with the blood in the lungs evinces, that it muſt act as a ſtimulus to the ſanguiferous ſyſtem, as the motions of the heart and arteries preſently ceaſe, when animals are immerſed in airs which poſſeſs no oxygen. It may alſo ſubſequently anſwer another important purpoſe, as it is probable that the affords it material for the production of the ſenſorial power; which is ſuppoſed to be ſecreted in the brain or medullary part of the nerves; and that the perpetual demand of this fluid in reſpiration is occaſioned by the ſenſorial power, which is ſuppoſed to be produced from it, being too ſubtle to be long confined in any part of the ſyſtem.

Another proof of the ſtimulant quality of oxygen appears from the increaſed acrimony, which the matter of a common abſceſs poſſeſſes, after it has been expoſed to the air of the atmoſphere, but not before; and probably all other contagious matters owe their fever-producing property to having been converted into acids by their union with oxygen. See Claſs II. 1. 8.

As oxygen penetrates the fine moiſt membranes of the air-veſſels of the lungs, and unites with the blood by a chemical attraction, as is ſeen to happen, when blood is drawn into a baſon, the lower ſurface of the craſſamentum is of a very dark red ſo long as it is covered from the air by the upper ſurface, but becomes florid in a ſhort time on its being expoſed to the atmoſphere; the manner of its introduction into the ſyſtem is not probably by animal abſorption but by chemical attraction, in which circumſtance it differs from the fluids before mentioned both of heat and electricity, and of ether and eſſential oils.

As oxygen has the property of paſſing through moiſt animal membranes, as firſt diſcovered by the great Dr. Prieſtley, it is probable it might be of uſe in vibices, and petechiæ in fevers, and in other bruiſes; if the ſkin over thoſe parts was kept moiſt by warm water, and covered with oxygen gas by means of an inverted glaſs, or even by expoſing the parts thus moiſtened to the atmoſphere, as the dark coloured extravaſated blood might thus become florid, and by its increaſe of ſtimulus facilitate its reabſorption.

Two weak patients, to whom I gave oxygen gas in as pure a ſtate as it can eaſily be procured from Exeter manganeſe, and in the quantity of about four gallons a day, ſeemed to feel refreſhed, and ſtronger, and to look better immediately after reſpiring it, and gained ſtrength in a ſhort time. Two others, one of whom laboured under confirmed hydrothorax, and the other under a permanent and uniform difficulty of reſpiration, were not refreſhed, or in any way ſerved by the uſe of oxygen in the above quantity of four gallons a day for a fortnight, which I aſcribed to the inirritability of the diſeaſed lungs. For other caſes the reader is referred to the publications of Dr. Beddoes; Conſiderations on the Uſe of Factitious Airs, ſold by Johnſon, London.

Its effects would probably have been greater in reſpect to the quantity breathed, if it had been given in a dilute ſtate, mixed with 10 or 20 times its quantity of atmoſpheric air, as otherwiſe much of it returns by expiration without being deprived of its quality, as may be ſeen by the perſon breathing on the flame of a candle, which it enlarges. See the Treatiſe of Dr. Beddoes above mentioned.

Mr. Scot in his letters in the Bombay Courier gave the black calciform ore of manganeſe in the quantity, he ſays, of ſeveral drachms a day without

out any inconvenience to a venereal patient, hoping to ſerve him by the oxygen contained in that calx. I have formerly given lapis calaminaris to the quantity of 20 grains twice a day in conſumption, without inconvenience, and I ſuppoſe this calciform ore of zinc, as well as the ruſt of iron, may be an union of thoſe metals with oxygen, and may probably be given internally with more ſafety than calces of lead, which were once famous in conſumptions. See Claſs II. 1. 5. 2. and Article IV. 2. 7. 1.

V. Thoſe paſſions, which are attended with pleaſurable ſenſation, excite the ſyſtem into increaſed action in conſequence of that ſenſation, as joy, and love, as is ſeen by the fluſh of the ſkin. Thoſe paſſions, which are attended with diſagreeable ſenſation, produce torpor in general by the expenſe of ſenſorial power occaſioned by inactive pain; unleſs volition be excited in conſequence of the painful ſenſation; and in that caſe an increaſed activity of the ſyſtem occurs; thus paleneſs and coldneſs are the conſequence of fear, but warmth and redneſs are the conſequence of anger.

VI. Beſides the exertions of the ſyſtem occaſioned by increaſed ſtimuli, and conſequent irritation, and by the paſſions of the mind above deſcribed, the increaſed actions occaſioned by exerciſe belong to this article. Theſe may be divided into the actions of the body in conſequence of volition, which is generally termed labour; or ſecondly, in conſequence of agreeable ſenſation, which is termed play or ſport; thirdly, the exerciſe occaſioned by agitation, as in a carriage or on horſeback; fourthly, that of friction, as with a bruſh or hand, ſo much uſed in the baths of Turkey; and laſtly, the exerciſe of ſwinging.

The firſt of theſe modes of exerciſe is frequently carried to great exceſs even amongſt our own labourers, and more ſo under the laſh of ſlavery; ſo that the body becomes emaciated and ſinks under either the preſent hardſhips, or by a premature old age. The ſecond mode of exerciſe is ſeen in the play of all young animals, as kittens, and puppies, and children; and is ſo neceſſary to their health as well as to their pleaſure, that thoſe children, which are too much confined from it, not only become pale-faced and bloated, with tumid bellies, and conſequent worms, but are liable to get habits of unnatural actions, as twitching of their limbs, or ſome parts of their countenance; together with an ill-humoured or diſcontented mind.

Agitation in a carriage or on horſeback, as it requires ſome little voluntary exertion to preſerve the body perpendicular, but much leſs voluntary exertion than in walking, ſeems the beſt adapted to invalides; who by theſe means obtain exerciſe principally by the ſtrength of the horſe, and do not therefore too much exhauſt their own ſenſorial power. The uſe of friction with a bruſh or hand, for half an hour or longer morning and evening, is ſtill better adapted to thoſe, who are reduced to extreme debility; and none of their own ſenſorial power is thus expended, and affords ſomewhat like the warm-bath activity without ſelf-exertion, and is uſed as a luxury after warm bathing in many parts of Aſia.

Another kind of exerciſe is that of ſwinging, which requires ſome exertion to keep the body perpendicular, or pointing towards the centre of the ſwing, but is at the ſame time attended with a degree of vertigo; and is deſcribed in Claſs II. 1. 6. 7. IV. 2. 1. 10. Sup. I. 3. and 15.

The neceſſity of much exerciſe has perhaps been more inſiſted upon by phyſicians, than nature ſeems to demand. Few animals exerciſe themſelves ſo as to induce viſible ſweat, unleſs urged to it by mankind, or by fear, or hunger. And numbers of people in our market towns, of ladies particularly, with ſmall fortunes, live to old age in health, without any kind of exerciſe of body, or much activity of mind.

In ſummer weak people cannot continue too long in the air, if it can be done without fatigue; and in winter they ſhould go out ſeveral times in a day for a few minutes, uſing the cold air like a cold-bath, to invigorate and render them more hardy.

III. CATALOGUE OF THE INCITANTIA.

I. Papaver ſomniferum; poppy, opium.
Alcohol, wine, beer, cyder.
Prunus lauro-ceraſus; laurel, diſtilled water from the leaves.
Prunus ceraſus; black cherry, diſtilled water from the kernels.
Nicotiana tabacum; tobacco; the eſſential oil, decoction of the leaf.
Atropa belladonna; deadly nightſhade, the berries.
Datura ſtramoneum; thorn-apple, the fruit boiled in milk.
Hyoſcyamus reticulatus; henbane, the ſeeds and leaves.
Cynogloſſum; hounds tongue.
Meniſpermum, cocculus; Indian berry.
Amygdalus amarus; bitter almond.
Cicuta; hemlock. Conium maculatum?
Strychnos nux vomica?
Delphinium ſtaviſagria?
II. Externally, heat, electricity.
III. Ether, eſſential oils.
IV. Oxygen gas.
V. Paſſions of love, joy, anger.
VI. Labour, play, agitation, friction.

Art. III.

SECERNENTIA.

I. Those things which increaſe the irritative motions, which conſtitute ſecretion, are termed ſecernentia; which are as various as the glands, which they ſtimulate into action.

1. Diaphoretics, as aromatic vegetables, eſſential oils, ether, volatile alcali, neutral ſalts, antimonial preparations, external heat, exerciſe, friction, cold water for a time with ſubſequent warmth, bliſters, electric fluid.

2. Sialagogues, as mercury internally, and pyrethrum externally.

3. Expectorants, as ſquill, onions, gum ammoniac, ſeneka root, mucilage: ſome of theſe increaſe the pulmonary perſpiration, and perhaps the pulmonary mucus.

4. Diuretics, as neutral ſalts, fixed alcali, balſams, reſins, aſparagus, cantharides.

5. Cathartics of the mild kind, as ſena, jalap, neutral ſalts, manna. They increaſe the ſecretions of bile, pancreatic juice, and inteſtinal mucus.

6. The mucus of the bladder is increaſed by cantharides, and perhaps by oil of turpentine.

7. The mucus of the rectum by aloe internally, by clyſters and ſuppoſitories externally.

8. The mucus of the cellular membrane is increaſed by bliſters and ſinapiſms.

9. The mucus of the noſtrils is increaſed by errhines of the milder kind, as marum, common ſnuff.

10. The ſecretion of tears is increaſed by volatile ſalts, the vapour of onions, by grief, and joy.

11. All thoſe medicines increaſe the heat of the body, and remove thoſe pains, which originate from a defect of motion in the veſſels, which perform ſecretion; as pepper produces a glow on the ſkin, and balſam of Peru is ſaid to relieve the flatulent colic. But theſe medicines differ from the preceding claſs, as they neither induce coſtiveneſs nor deep coloured urine in their uſual doſe, nor intoxication in any doſe.

12. Yet if any of theſe are uſed unneceſſarily, it is obvious, like the incitantia, that they muſt contribute to ſhorten our lives by ſooner rendering peculiar parts of the ſyſtem diſobedient to their natural ſtimuli. Of thoſe in daily uſe the

great exceſs of common ſalt is probably the moſt pernicious, as it enters all our cookery, and is probably one cauſe of ſcrofula, and of ſea-ſcurvy, when joined with other cauſes of debility. See Botanic Garden, Part II. Canto IV. line 221. Spices taken to exceſs by ſtimulating the ſtomach, and the veſſels of the ſkin by aſſociation, into unneceſſary action, contribute to weaken theſe parts of the ſyſtem, but are probably leſs noxious than the general uſe of ſo much ſalt.

II. OBSERVATIONS ON THE SECERNENTIA.

I. 1. Some of the medicines of this claſs produce abſorption in ſome degree, though their principal effect is exerted on the ſecerning part of our ſyſtem. We ſhall have occaſion to obſerve a ſimilar circumſtance in the next claſs of medicines termed Sorbentia; as of theſe ſome exert their effects in a ſmaller degree on the ſecerning ſyſtem. Nor will this ſurpriſe any one, who has obſerved, that all natural objects are preſented to us in a ſtate of combination; and that hence the materials, which produce theſe different effects, are frequently found mingled in the ſame vegetable. Thus the pure aromatics increaſe the action of the veſſels, which ſecrete the perſpirable matter; and the pure aſtringents increaſe the action of the veſſels, which abſorb the mucus from the lungs, and other cavities of the body; hence it muſt happen, that nutmeg, which poſſeſſes both theſe qualities, ſhould have the double effect above mentioned.

Other drugs have this double effect, and belong either to the claſs of Secernentia or Sorbentia, according to the doſe in which they are exhibited. Thus a ſmall doſe of alum increaſes abſorption, and induces coſtiveneſs; and a large one increaſes the ſecretions into the inteſtinal canal, and becomes cathartic. And this accounts for the conſtipation of the belly left after the purgative quality of rhubarb ceaſes, for it increaſes abſorption in a ſmaller doſe, and ſecretion in a greater. Hence when a part of the larger doſe is carried out of the habit by ſtools, the ſmall quantity which remains induces coſtiveneſs. Hence rhubarb exhibited in ſmall doſes, as two or three grains twice a day, ſtrengthens the ſyſtem by increaſing the action of the abſorbent veſſels, and of the inteſtinal canal.

2. Diaphoretics. The perſpiration is a ſecretion from the blood in its paſſage through the capillary veſſels, as other ſecretions are produced in the termination of the arteries in the various glands. After this ſecretion the blood loſes its florid colour, which it regains in its paſſage through the lungs; which evinces that ſomething beſides water is ſecreted on the ſkins of animals.

No ſtatical experiments can aſcertain the quantity of our perſpiration; as a continued abſorption of the moiſture of the atmoſphere exiſts at the ſame time both by the cutaneous and pulmonary lymphatics.

3. Every gland is capable of being excited into greater exertions by an appropriated ſtimulus applied either by its mixture with the blood immediately to the ſecerning veſſel, or applied externally to its excretory duct. Thus mercury internally promotes an increaſed ſalivation, and pyrethrum externally applied to the excretory ducts of the ſalival glands. Aloes ſtimulate the rectum internally mixed with the circulating blood; and ſea-ſalt by injection externally. Now as the capillaries, which ſecrete the perſpirable matter, lie near the ſurface of the body, the application of external heat acts immediately on their excretory ducts, and promotes perſpiration; internally thoſe drugs which poſſeſs a fragrant eſſential oil, or ſpiritus rector, produce this effect, as the aromatic vegetables, of which the number is very great.

4. It muſt be remembered, that a due quantity of ſome aqueous vehicle muſt be given to ſupport this evacuation; otherwiſe a burning heat without much viſible ſweat muſt be the conſequence. When the ſkin acquires a degree of heat much above 108, as appears by Dr. Alexander's

ander's experiments, no viſible ſweat is produced; which is owing to the great heat of the ſkin evaporating it as haſtily, as it is ſecreted; and, where the ſweat is ſecreted in abundance, its evaporation cannot carry off the exuberant heat, like the vapour of boiling water; becauſe a great part of it is wiped off, or abſorbed by the bed-clothes; or the air about the patient is not changed ſufficiently often, as it becomes ſaturated with the perſpirable matter. And hence it is probable, that the waſte of perſpirable matter is as great, or greater, when the ſkin is hot and dry, as when it ſtands in drops on the ſkin; as appears from the inextinguiſhable thirſt.

Hence Dr. Alexander found, that when the heat of the body was greater than 108, nothing produced ſweats but repeated draughts of cold water; and of warm fluids, when the heat was much below that degree. And that cold water which procured ſweats inſtantaneouſly when the heat was above 108, ſtopped them as certainly when it was below that heat; and that flannels, wrung out of warm water and wrapped round the legs and thighs, were then moſt certainly productive of ſweats.

5. The diaphoretics are all ſaid to ſucceed much better, if given early in the morning, about an hour before ſun-riſe, than at any other time; which is owing to the great excitability of

every part of the ſyſtem after the ſenſorial power has been accumulated during ſleep. In thoſe, who have hectic fever, or the febricula, or nocturnal fever of debility, the morning ſweats are owing to the decline of the fever-fit, as explained in Sect. XXXII. 9. In ſome of theſe patients the ſweat does not occur till they awake; becauſe then the ſyſtem is ſtill more excitable than during ſleep, becauſe the aſſiſtance of the voluntary power in reſpiration facilitates the general circulation. See Claſs I. 2. 1. 3.

6. It muſt be obſerved, that the ſkin is very dry and hard to the touch, where the abſorbents, which open on its ſurface, do not act; as in ſome dropſies, and other diſeaſes attended with great thirſt. This dryneſs, and ſhrivelled appearance, and roughneſs, are owing to the mouths of the abſorbents being empty of their accuſtomed fluid, and is diſtinguiſhable from the dryneſs of the ſkin above mentioned in the hot fits of fever, by its not being attended with heat.

As the heat of the ſkin in the uſual temperature of the air always evinces an increaſed perſpiration, whether viſible or not, the heat being produced along with the increaſe of ſecretion; it follows, that a defect of perſpiration can only exiſt, when the ſkin is cold.

7. Volatile alcali is a very powerful diaphoretic, and particularly if exhibited in wine-whey; twenty drops of ſpirit of hartſhorn every half hour in half a pint of wine-whey, if the patient be kept in a moderately warm bed, will in a few hours elicit moſt profuſe ſweats.

Neutral ſalts promote inviſible perſpiration, when the ſkin is not warmed much externally, as is evinced from the great thirſt, which ſucceeds a meal of ſalt proviſions, as of red herrings. When theſe are ſufficiently diluted with water, and the ſkin kept warm, copious ſweats without inflaming the habit, are the conſequence. Half an ounce of vinegar ſaturated with volatile alcali, taken every hour or two hours, well anſwers this purpoſe; and is preferable perhaps in general to all others, where ſweating is advantageous. Boerhaave mentions one cured of a fever by eating red-herrings or anchovies, which, with repeated draughts of warm water or tea, would I ſuppoſe produce copious perſpiration.

Antimonial preparations have alſo been of late much uſed with great advantage as diaphoretics. For the hiſtory and uſe of theſe preparations I ſhall refer the reader to the late writers on the Materia Medica, only obſerving that the ſtomach becomes ſo ſoon habituated to its ſtimulus, that the ſecond doſe may be conſiderably increaſed, if the firſt had no operation.

Where it is adviſable to procure copious ſweats, the emetics, as ipecacuanha, joined with opiates, as in Dover's powder, produce this effect with greater certainty than the above.

8. We muſt not diſmiſs this ſubject without obſerving, that perſpiration is deſigned to keep the ſkin flexile, as the tears are intended to clean and lubricate the eye; and that neither of theſe fluids can be conſidered as excretions in their natural ſtate, but as ſecretions. See Claſs I. 1. 2. 3. And that therefore the principal uſe of diaphoretic medicines is to warm the ſkin, and thence in conſequence to produce the natural degree of inſenſible perſpiration in languid habits.

9. When the ſkin of the extremities is cold, which is always a ſign of preſent debility, the digeſtion becomes frequently impaired by aſſociation, and cardialgia or heartburn is induced from the vinous or acetous fermentation of the aliment. In this diſeaſe diaphoretics, which have been called cordials, by their action on the ſtomach reſtore its exertion, and that of the cutaneous capillaries by their aſſociation with it, and the ſkin becomes warm, and the digeſtion more vigorous.

10. But a bliſter acts with more permanent and certain effect by ſtimulating a part of the ſkin, and thence affecting the whole of it, and of

the ſtomach by aſſociation, and thence removes the moſt obſtinate heartburns and vomitings. From this the principal uſe of bliſters is underſtood, which is to invigorate the exertions of the arterial and lymphatic veſſels of the ſkin, producing an increaſe of inſenſible perſpiration, and of cutaneous abſorption; and to increaſe the action of the ſtomach, and the conſequent power of digeſtion; and thence by ſympathy to excite all the other irritative motions: hence they relieve pains of the cold kind, which originate from defect of motion; not from their introducing a greater pain, as ſome have imagined, but by ſtimulating the torpid veſſels into their uſual action; and thence increaſing the action and conſequent warmth of the whole ſkin, and of all the parts which are aſſociated with it.

II. 1. *Sialagogues.* The preparations of mercury conſiſt of a ſolution or corroſion of that metal by ſome acid; and, when the doſe is known, it is probable that they are all equally efficacious. As their principal uſe is in the cure of the venereal diſeaſe, they will be mentioned in the catalogue amongſt the ſorbentia. Where ſalivation is intended, it is much forwarded by a warm room and warm clothes; and prevented by expoſing the patient to his uſual habits of cool air and dreſs, as the mercury is then more liable to go off by the bowels.

2. Any acrid drug, as pyrethrum, held in the mouth acts as a ſialagogue externally by ſtimulating the excretory ducts of the ſalivary glands; and the ſiliqua hirſuta applied externally to the parotid gland, and even hard ſubſtances in the ear, are ſaid to have the ſame effect. Maſtich chewed in the mouth emulges the ſalivary glands.

3. The unwiſe cuſtom of chewing and ſmoaking tobacco for many hours in a day not only injures the ſalivary glands, producing dryneſs in the mouth when this drug is not uſed, but I ſuſpect that it alſo produces ſcirrhus of the pancreas. The uſe of tobacco in this immoderate degree injures the power of digeſtion, by occaſioning the patient to ſpit out that ſaliva, which he ought to ſwallow; and hence produces that flatulency, which the vulgar unfortunately take it to prevent. The mucus, which is brought from the fauces by hawking, ſhould be ſpit out, as well as that coughed up from the lungs; but that which comes ſpontaneouſly into the mouth from the ſalivary glands, ſhould be ſwallowed mixed with our food or alone for the purpoſes of digeſtion. See Claſs I. 2. 2. 7.

III. 1. Expectorants are ſuppoſed to increaſe the ſecretion of mucus in the branches of the windpipe, or to increaſe the perſpiration of the lungs ſecreted at the terminations of the bronchial artery.

2. If any thing promotes expectoration toward the end of peripneumonies, when the inflammation is reduced by bleeding and gentle cathartics, ſmall repeated bliſters about the cheſt, with tepid aqueous and mucilaginous or oily liquids, are more advantageous than the medicines generally enumerated under this head; the bliſters by ſtimulating into action the veſſels of the ſkin produce by aſſociation a greater activity of thoſe of the mucous membrane, which lines the branches of the windpipe, and air-cells of the lungs; and thus after evacuation they promote the abſorption of the mucus and conſequent healing of the inflamed membrane, while the diluting liquids prevent this mucus from becoming too viſcid for this purpoſe, or facilitate its expuition.

Bliſters, one at a time, on the ſides or back, or on the ſternum, are alſo uſeful towards the end of peripneumonies, by preventing the evening acceſs of cold fit, and thence preventing the hot fit by their ſtimulus on the ſkin; in the ſame manner as five drops of laudanum by its ſtimulus on the ſtomach. For the increaſed actions of the veſſels of the ſkin or ſtomach excite a greater quantity of the ſenſorial power of aſſociation, and thus prevent the torpor of the other parts of the ſyſtem; which, when patients are debilitated, is ſo liable to return in the evening.

3. Warm bathing is of great ſervice towards the end of peripneumony to promote expectoration, eſpecially in thoſe children who drink too little aqueous fluids, as it gently increaſes the action of the pulmonary capillaries by their conſent with the cutaneous ones, and ſupplies the ſyſtem with aqueous fluid, and thus dilutes the ſecreted mucus.

Some have recommended oil externally around the cheſt, as well as internally, to promote expectoration; and upon the noſe, when its mucous membrane is inflamed, as in common catarrh.

IV. 1. Diuretics. If the ſkin be kept warm, moſt of theſe medicines promote ſweat inſtead of urine; and if their doſe is enlarged, moſt of them become cathartic. Hence the neutral ſalts are uſed in general for all theſe purpoſes. Thoſe indeed, which are compoſed of the vegetable acid, are moſt generally uſed as ſudorifics; thoſe with the nitrous acid as diuretics; and thoſe with the vitriolic acid as cathartics: while thoſe united with the marine acid enter our common nutriment, as a more general ſtimulus. All theſe increaſe the acrimony of the urine, hence it is retained a leſs time in the bladder; and in conſequence leſs of it is reabſorbed into the ſyſtem, and the apparent quantity is greater, as more is evacuated from the bladder; but it is not certain from thence, that a greater quantity is ſecreted by the kidneys. Hence nitre, and other neutral ſalts, are erroneouſly given in the gonorrhœa; as they augment the pain of making water by their ſtimulus on the exeoriated or inflamed urethra. They are alſo erroneouſly given in catarrhs or coughs, where the diſcharge is too thin and ſaline, as they increaſe the frequency of coughing.

2. Balſam of Copaiva is thought to promote urine more than the other native balſams; and common reſin is ſaid to act as a powerful diuretic in horſes. Theſe are alſo much recommended in gleets, and in fluor albus, perhaps more than they deſerve; they give a violet ſmell to the urine, and hence probably increaſe the ſecretion of it.

Calcined egg-ſhells are ſaid to promote urine, perhaps from the phoſphoric acid they contain.

3. Cold air and cold water will increaſe the quantity of urine by decreaſing the abſorption from the bladder; and neutral and alkalious ſalts and cantharides by ſtimulating the neck of the bladder to diſcharge the urine as ſoon as ſecreted; and alcohol, as gin and rum, at the beginning of intoxication, if the body be kept cool, occaſion

much urine by inverting the urinary lymphatics, and thence pouring a fluid into the bladder, which never paſſed the kidneys. But it is probable, that thoſe medicines, which give a ſcent to the urine, as the balſams and reſins, but particularly aſparagus and garlic, are the only drugs, which truly increaſe the ſecretion of the kidneys. Alcohol however, uſed as above mentioned, and perhaps great doſes of tincture of cantharides, may be conſidered as draſtic diuretics, as they pour a fluid into the bladder by the retrograde action of the lymphatics, which are in great abundance ſpread about the neck of it. See Sect. XXIX. 3.

V. Mild cathartics. The ancients believed that ſome purges evacuated the bile, and hence were termed Cholagogues; others the lymph, and were termed Hydragogues; and that in ſhort each cathartic ſelected a peculiar humour, which it diſcharged. The moderns have too haſtily rejected this ſyſtem; the ſubject well deſerves further obſervation.

Calomel given in the doſe from ten to twenty grains, ſo as to induce purging without the aſſiſtance of other drugs, appears to me to particularly increaſe the ſecretion of bile, and to evacuate it; aloe ſeems to increaſe the ſecretion of the inteſtinal mucus; and it is probable that the pancreas and ſpleen may be peculiarly ſtimulated into action by ſome other of this tribe of medicines; whilſt others of them may ſimply ſtimulate the inteſtinal canal to evacuate its contents, as the bile of animals. It muſt be remarked, that all theſe cathartic medicines are ſuppoſed to be exhibited in their uſual doſes, otherwiſe they become draſtic purges, and are treated of in the Claſs of Invertentia.

VI. The mucus of the bladder is ſeen in the urine, when cantharides have been uſed, either internally or externally, in ſuch doſes as to induce the ſtrangury. Spirit of turpentine is ſaid to have the ſame effect. I have given above a dram of it twice a day floating on a glaſs of water in chronic lumbago without this effect, and the patient gradually recovered. Phoſphorus may poſſibly affect the mucous glands of the urethra like cantharides. See Impotentia, Claſs II. 2. 2. 3.

VII. Aloe given internally ſeems to act chiefly on the rectum and ſphincter ani, producing teneſmus and piles. Externally in clyſters or ſuppoſitories, common ſalt ſeems to act on that bowel with greater certainty. But where the thread worms or aſcarides exiſt, 60 or 100 grains of aloes reduced to powder and boiled in a pint of gruel, and uſed as a clyſter twice a week for three months, has frequently deſtroyed them.

Might not the hairs of ſiliqua hirſuta be uſed in an injection for this purpoſe? See Claſs I. 1. 4. 14.

VIII. The external application of cantharides by ſtimulating the excretory ducts of the capillary glands produces a great ſecretion of ſubcutaneous mucus with pain and inflammation; which mucaginous fluid, not being able to permeate the cuticle, raiſes it up; a ſimilar ſecretion and elevation of the cuticle is produced by actual fire; and by cauſtic materials, as by the application of the juice of the root of white briony, or bruiſed muſtard-ſeed. Experiments are wanting to introduce ſome acrid application into practice inſtead of cantharides, which might not induce the ſtrangury.

Muſtard-ſeed alone is too acrid, and if it be ſuffered to lie on the ſkin many minutes is liable to produce a ſlough and conſequent ulcer, and ſhould therefore be mixed with flour when applied to cold extremities. Volatile alkali properly diluted might ſtimulate the ſkin without inducing ſtrangury.

IX. The mild errhines are ſuch as moderately ſtimulate the membrane of the noſtrils, ſo as to increaſe the ſecretion of naſal mucus; as is ſeen in thoſe, who are habituated to take ſnuff. The ſtronger errhines are mentioned in Art. V. 2. 3.

X. The ſecretion of tears is increaſed either by applying acrid ſubſtances to the eye; or acrid vapours, which ſtimulate the excretory duct of the lacrymal gland; or by applying them to the noſtrils, and ſtimulating the excretory duct of the lacrymal ſack, as treated of in the Section on Inſtinct.

Or the ſecretion of tears is increaſed by the aſſociation of the motions of the excretory duct of the lacrymal ſack with ideas of tender pleaſure, or of hopeleſs diſtreſs, as explained in Sect. XVI. 8. 2. and 3.

XI. The ſecretion of ſenſorial power in the brain is probably increaſed by opium or wine, becauſe when taken in certain quantity an immediate increaſe of ſtrength and activity ſucceeds for a time, with conſequent debility if the quantity taken be ſo great as to intoxicate in the leaſt degree. The neceſſity of perpetual reſpiration ſhews, that the oxygen of the atmoſphere ſupplies the ſource of the ſpirit of animation; which is conſtantly expended, and is probably too fine to be long contained in the nerves after its production in the brain. Whence it is probable, that the reſpiration of oxygen gas mixed with common air may increaſe the ſecretion of ſenſorial power; as indeed would appear from its exhilarating effect on moſt patients.

III. Catalogue

III. Catalogue of the Secernentia.

I. Diaphoretics.

1. Amomum zinziber, ginger. Caryophyllus aromaticus, cloves. Piper indicum, pepper. Capſicum. Cardamomum. Pimento, myrtus pimenta. Canella alba. Serpentaria virginiana, ariſtolochia ſerpentaria, guaiacum. Saſſafras, laurus ſaſſafras. Opium. Wine.
2. Eſſential oils of cinnamon, laurus cinnamomum. Nutmeg, myriſtica moſchata. Cloves, caryophyllus aromaticus. Mint, mentha. Camphor, laurus camphora. Ether.
3. Volatile ſalts, as of ammoniac and of hartſhorn. Sal cornu cervi.
4. Neutral ſalts, as thoſe with vegetable acid; or with marine acid, as common ſalt. Halex, red-herring, anchovy.
5. Preparations of antimony, as emetic tartar, antimonium tartarizatum, wine of antimony. James's powder.
6. External applications. Bliſters. Warm bath. Warm air. Exerciſe. Friction.
7. Cold water with ſubſequent warmth.

II. Sialagogues. Preparations of mercury, hydrargyrus. Pyrethrum, anthemis pyrethrum, tobacco, cloves, pepper, cowhage, ſtizolobium ſiliqua hirſuta. Maſtich, piſtacia lentiſcus.

III. Expectorants.

1. Squill, ſcilla maritima, garlic, leek, onion, allium, aſafœtida, ferula aſafœtida, gum ammoniac, benzoin, tar, pix liquida, balſam of Tolu.
2. Root of ſeneka, polygala ſeneka, of elecampane, inula helenium.
3. Marſh-mallow, althæa, coltsfoot, tuſſilago farfara, gum arabic, mimoſa nilotica, gum tragacanth, aſtragalus tragacantha. Decoction of barley, hordeum diſtichon. Expreſſed oils. Spermaceti, ſoap. Extract of liquorice, glycyrrhiza glabra. Sugar. Honey.
4. Externally bliſters. Oil. Warm bath.

IV. Mild diuretics.

1. Nitre, kali acetatum, other neutral ſalts.
2. Fixed alkali, ſoap, calcined egg-ſhells.
3. Turpentine. Balſam of Copaiva. Reſin. Olibanum.
4. Aſparagus, garlic, wild daucus. Parſley, apium. Fennel, fæniculum, parcira brava, ciſſampelos?
5. Externally cold air, cold water.
6. Alcohol. Tincture of cantharides. Opium,

V. Mild cathartics.

1. Sweet ſubacid fruits. Prunes, prunus domeſtica. Caſſia fiſtula. Tamarinds, cryſtals of tartar, unrefined ſugar. Manna. Honey.
2. Whey of milk, bile of animals.
3. Neutral ſalts, as Glauber's ſalt, vitriolated tartar, ſea-water, magneſia alba, ſoap.
4. Gum guaiacum. Balſam of Peru. Oleum ricini, caſtor-oil, oil of almonds, oil of olives, ſulphur.
5. Senna, caſſia ſenna, jalap, aloe, rhubarb, rheum palmatum.
6. Calomel. Emetic tartar, antimonium tartarizatum.

VI. Secretion of mucus of the bladder is increaſed by cantharides, by ſpirit of turpentine? Phoſphorus?

VII. Secretion of mucus of the rectum is increaſed by aloe internally, by various clyſters and ſuppoſitories externally.

VIII. Secretion of ſubcutaneous mucus is increaſed by bliſters of cantharides, by application of a thin ſlice of the freſh root of white briony, by ſinapiſms, by root of horſe-radiſh, cochlearia armoracia. Volatile alcali.

IX. Mild errhines. Marjoram. Origanum. Marum, tobacco.

X. Secretion of tears is increaſed by vapour of ſliced onion, of volatile alcali. By pity, or ideas of hopeleſs diſtreſs.

XI. Secretion of ſenſorial power in the brain is probably increaſed by opium, by wine, and perhaps by oxygen gas added to the common air in reſpiration.

ART. IV.

SORBENTIA.

I. THOSE THINGS which increaſe the irritative motions, which conſtitute abſorption, are termed ſorbentia; and are as various as the abſorbent veſſels which they ſtimulate into action.

1. Cutaneous abſorption is increaſed by auſtere acids, as of vitriol; hence they are believed to check colliquative ſweats, and to check the eruption of ſmall-pox, and contribute to the cure of the itch, and tinea; hence they thicken the ſaliva in the mouth, as lemon-juice, crab-juice, ſloes.

2. Abſorption from the mucous membrane is increaſed by opium, and Peruvian bark, internally;

nally; and by blue vitriol externally. Hence the expectoration in coughs, and the mucous diſcharge from the urethra, are thickened and leſſened.

3. Abſorption from the cellular membrane is promoted by bitter vegetables, and by emetics, and cathartics. Hence matter is thickened and leſſened in ulcers by opium and Peruvian bark; and ſerum is abſorbed in anaſarca by the operation of emetics and cathartics.

4. Venous abſorption is increaſed by acrid vegetables; as water-creſs, cellery, horſe-radiſh, muſtard. Hence their uſe in ſea-ſcurvy, the vibices of which are owing to a defect of venous abſorption; and by external ſtimulants, as vinegar, and by electricity, and perhaps by oxygen.

5. Inteſtinal abſorption is increaſed by aſtringent vegetables, as rhubarb, galls; and by earthy ſalts, as alum; and by argillaceous and calcareous earth.

6. Hepatic abſorption is increaſed by metallic ſalts, hence calomel and ſal martis are ſo efficacious in jaundice, worms, chloroſis, dropſy.

7. Venereal virus in ulcers is abſorbed by the

ſtimulus of mercury; hence they heal by the uſe of this medicine.

8. Veneſection, hunger, thirſt, and violent evacuations, increaſe all abſorptions; hence ſweating produces coſtiveneſs.

9. Externally bitter aſtringent vegetables, earthy and metallic ſalts, and bandages, promote the abſorption of the parts on which they are applied.

10. All theſe in their uſual doſes do not increaſe the natural heat; but they induce coſtiveneſs, and deep-coloured urine with earthy ſediment.

In greater doſes they invert the motions of the ſtomach and lacteals; and hence vomit or purge, as carduus benedictus, rhubarb. They promote perſpiration, if the ſkin be kept warm; as camomile tea, and teſtaceous powders, have been uſed as ſudorifics.

The preparations of antimony vomit, purge, or ſweat, either according to the quantity exhibited, or as a part of what is given is evacuated. Thus a quarter of a grain of emetic tartar (if well prepared) will promote a diaphoreſis, if the ſkin be kept warm; half a grain will procure a ſtool or two firſt, and ſweating afterward; and a grain

will

will generally vomit, and then purge, and laſtly ſweat the patient. In leſs quantity it is probable, that this medicine acts like other metallic ſalts, as ſteel, zinc, or copper in ſmall doſes; that is, that it ſtrengthens the ſyſtem by its ſtimulus. As camomile and rhubarb in different doſes vomit, or purge, or act as ſtimulants ſo as to ſtrengthen the ſyſtem.

Some of the medicines of this claſs of ſorbentia have been termed tonics by ſome authors, as giving due tone to the animal fibre. But it ſhould be obſerved, that tone is a mechanical term, applicable only to muſical ſtrings, and like bracing and relaxation, cannot be applied to animal life except metaphorically. The ſame may be obſerved of the word reaction, uſed by ſome modern authors, which in its proper ſignification is a mechanical term inapplicable to the laws of life except metaphorically.

II. OBSERVATIONS ON THE SORBENTIA.

I. 1. As there is great difference in the apparent ſtructure of the various glands, and of the fluids which they ſelect from the blood, theſe glands muſt poſſeſs different kinds of irritability, and are therefore ſtimulated into ſtronger or unnatural actions by different articles of the materia medica, as ſhewn in the ſecernentia. Now as the abſorbent veſſels are likewiſe glands, and drink up or ſelect different fluids, as chyle, water, mucus, with a part of every different ſecretion, as a part of the bile, a part of the ſaliva, a part of the urine, &c. it appears, that theſe abſorbent veſſels muſt likewiſe poſſeſs different kinds of irritability, and in conſequence muſt require different articles of the materia medica to excite them into unuſual action. This part of the ſubject has been ſo little attended to, that the candid reader will find in this article a great deal to excuſe.

It was obſerved, that ſome of the ſecernentia did in a leſs degree increaſe abſorption, from the combination of different properties in the ſame vegetable body; for the ſame reaſon ſome of the claſs of ſorbentia produce ſecretion in a leſs degree, as thoſe bitters which have alſo an aroma in their compoſition; theſe are known from their increaſing the heat of the ſyſtem above its uſual degree.

It muſt alſo be noted, that the actions of every part of the abſorbent ſyſtem are ſo aſſociated with each other, that the drugs which ſtimulate one branch increaſe the action of the whole; and the torpor or quieſcence of one branch weakens the exertions of the whole; or when one branch is excited into ſtronger action, ſome other branch has its actions weakened or inverted. Yet though peculiar branches of the abſorbent ſyſtem are ſtimulated into action by peculiar ſubſtances, there are other ſubſtances which ſeem to ſtimulate the whole ſyſtem, and that without immediately increaſing any of the ſecretions; as thoſe bitters which poſſeſs no aromatic ſcent, at the head of which ſtands the famed Peruvian bark, or cinchona.

2. Cutaneous abſorption. I have heard of ſome experiments, in which the body was kept cold, and was thought to abſorb more moiſture from the atmoſphere than at any other time. This however cannot be determined by ſtatical experiments; as the capillary veſſels, which ſecrete the perſpirable matter, muſt at the ſame time have been benumbed by the cold; and from their inaction there could not have been the uſual waſte of the weight of the body; and as all other muſcular exertions are beſt performed, when the body poſſeſſes its uſual degree of warmth, it is concluſive, that the abſorbent ſyſtem ſhould likewiſe do its office beſt, when it is not benumbed by external cold.

The auſtere acids, as of vitriol, lemon-juice, juice of crabs and ſloes, ſtrengthen digeſtion, and prevent that propenſity to ſweat ſo uſual to weak convaleſcents, and diminiſh the colliquative ſweats in hectic fevers; all which are owing to their increaſing the action of the external and internal cutaneous abſorption. Hence vitriolic acid is given in the ſmall-pox to prevent the too haſty or too copious eruption, which it effects, by increaſing the cutaneous abſorption. Vinegar, from the quantity of alcohol which it contains, exerts a contrary effect to that here deſcribed, and belongs to the incitantia; as an ounce of it promotes ſweat, and a fluſhing of the ſkin; at the ſame externally it acts as a venous abſorbent, as the lips become pale by moiſtening them with it. And it is ſaid, when taken internally in great and continued quantity, to induce paleneſs of the ſkin, and ſoftneſs of the bones.

The ſweet vegetable acids, as of ſeveral ripe fruits, are among the torpentia; as they are leſs ſtimulating than the general food of this climate, and are hence uſed in inflammatory diſeaſes.

Where the quantity of fluids in the ſyſtem is much leſſened, as in hectic fever, which has been of ſome continuance, or in ſpurious peripneumony, a grain of opium given at night will ſometimes prevent the appearance of ſweats; which is owing to the ſtimulus of opium increaſing the actions of the cutaneous abſorbents, more than thoſe of the ſecerning veſſels of the ſkin. Whence the ſecretion of perſpirable matter is not decreaſed, but its appearance on the ſkin is prevented by its more facile abſorption.

3. There is one kind of itch, which ſeldom appears between the fingers, is the leaſt infectious,

and moſt difficult to eradicate, and which has its cure much facilitated by the internal uſe of acid of vitriol. This diſeaſe conſiſts of ſmall ulcers in the ſkin, which are healed by whatever increaſes the cutaneous abſorption. The external application of ſulphur, mercury, and acrid vegetables, acts on the ſame principle; for the animalcula, which are ſeen in theſe puſtules, are the effect, not the cauſe, of them; as all other ſtagnating animal fluids, as the ſemen itſelf, abounds with ſimilar microſcopic animals. See Dyſentery, Claſs II. 1. 3. 18.

4. Young children have ſometimes an eruption upon the head called tinea, which diſcharges an acrimonious ichor inflaming the parts, on which it falls. This eruption I have ſeen ſubmit to the internal uſe of vitriolic acid, when only wheat-flour was applied externally. This kind of eruption is likewiſe frequently cured by teſtaceous powders; two materials ſo widely different in their chemical properties, but agreeing in their power of promoting cutaneous abſorption.

II. Abſorption from the mucous membrane is increaſed by applying to its ſurface the auſtere acids, as of vitriol, lemon-juice, crab-juice, ſloes. When theſe are taken into the mouth, they immediately thicken, and at the ſame time leſſen the quantity of the ſaliva; which laſt circumſtance cannot be owing to their coagulating the ſaliva, but to their increaſing the abſorption of the thinner parts of it. So alum applied to the tip of the tongue does not ſtop in its action there, but independent of its diffuſion it induces coheſion and corrugation over the whole mouth. (Cullen's Mat. Med. Art. Aſtringentia.) Which is owing to the aſſociation of the motions of the parts or branches of the abſorbent ſyſtem with each other.

Abſorption from the mucous membrane is increaſed by opium taken internally in ſmall doſes more than by any other medicine, as is ſeen in its thickening the expectoration in coughs, and the diſcharge from the noſtrils in catarrh, and perhaps the diſcharge from the urethra in gonorrhœa. The bark ſeems next in power for all theſe purpoſes.

Externally ſlight ſolutions of blue vitriol, as two or three grains to an ounce of water, applied to ulcers of the mouth, or to chancres on the glans penis, more powerfully induce them to heal than any other material.

Where the lungs or urethra are inflamed to a conſiderable degree, and the abſorption is ſo great, that the mucus is already too thick, and adheres to the membrane from its viſcidity, opiates and bitter vegetable and auſtere acids are improper; and mucilaginous diluents ſhould be uſed in their ſtead with veneſection and torpentia.

III. 1. Ab-

III. 1. Abſorption from the cellular membrane, and from all the other cavities of the body, is too ſlowly performed in ſome conſtitutions; hence the bloated pale complexion; and when this occurs in its greateſt degree, it becomes an univerſal dropſy. Theſe habits are liable to intermittent fevers, hyſteric paroxyſms, cold extremities, indigeſtion, and all the ſymptoms of debility.

The abſorbent ſyſtem is more ſubject to torpor or quieſcence than the ſecerning ſyſtem, both from the coldneſs of the fluids which are applied to it, as the moiſture of the atmoſphere, and from the coldneſs of the fluids which we drink; and alſo from its being ſtimulated only by intervals, as when we take our food; whereas the ſecerning ſyſtem is perpetually excited into action by the warm circulating blood; as explained in Sect. XXXII.

2. The Peruvian bark, camomile flowers, and other bitter drugs, by ſtimulating this cellular branch of the abſorbent ſyſtem prevents it from becoming quieſcent; hence the cold paroxyſms of thoſe agues, which ariſe from the torpor of the cellular lymphatics, are prevented, and the hot fits in conſequence. The patient thence preſerves his natural heat, regains his healthy colour, and his accuſtomed ſtrength.

Where the cold paroxyſm of an ague originates in the abſorbents of the liver, ſpleen, or other internal viſcus, the addition of ſteel to vegetable bitters, and eſpecially after the uſe of one doſe of calomel, much advances the cure.

And where it originates in any part of the ſecerning ſyſtem, as is probably the caſe in ſome kinds of agues, the addition of opium in the doſe of a grain and half, given about an hour before the acceſs of the paroxyſm, or mixed with chalybeate and bitter medicines, enſures the cure. Or the ſame may be effected by wine given inſtead of opium before the paroxyſm, ſo as nearly to intoxicate.

Theſe three kinds of agues are thus diſtinguiſhed; the firſt is not attended with any tumid or indurated viſcus, which the people call an ague cake, and which is evident to the touch. The ſecond is accompanied with a tumid viſcus; and the laſt has generally, I believe, the quartan type, and is attended with ſome degree of arterial debility.

The bark of the broad-leaved willow or ſalix caprea of Linneus, is much recommended as equal to the Peruvian bark given in the ſame or in greater quantity by Mr. White of Bath. Obſerv. and Exper. on broad-leafed willow. Vernor and Hood, London. A Dr. Gunz in Germany recommends alſo as a ſubſtitute for Peruvian bark, the bark of ſix ſpecies of willow, the ſalix alba, pentandra, fragilis, caprea, vitellina, and amygdalina.

lina. Dr. Gunz believes ſome of theſe barks to be more efficacious than the Peruvian. And as ſome of theſe willow-barks may be procured in great quantity, as they are ſtripped off from the willow twigs uſed by the baſket-makers in many parts of the country in the vernal months, it would ſeem to be an article worth attending to.

The root of geum urbanum, avens, is recommended as a ſubſtitute for Peruvian bark by Dr. Vogel, and ſaid to cure the quartan ague given in the doſe of half a dram every hour through the day. The datiſca cannabina of Linneus is alſo ſaid to equal the Peruvian bark in its febrifuge virtues. Medical and Phyſical Journal, Vol. I. p. 191.

3. This claſs of abſorbent medicines are ſaid to decreaſe irritability. After any part of our ſyſtem has been torpid or quieſcent, by whatever cauſe that was produced, it becomes afterwards capable of being excited into greater motion by ſmall ſtimuli; hence the hot fit of fever ſucceeds the cold one. As theſe medicines prevent torpor or quieſcence of parts of the ſyſtem, as cold hands or feet, which perpetually happen to weak conſtitutions, the ſubſequent increaſe of irritability of theſe parts is likewiſe prevented.

4. Theſe abſorbent medicines, including both the bitters, and metallic ſalts, and opiates, are

of great uſe in the dropſy by their promoting univerſal abſorption; but here evacuations are likewiſe to be produced, as will be treated of in the Invertentia.

5. The matter in ulcers is thickened, and thence rendered leſs corroſive, the ſaline part of it being reabſorbed by the uſe of bitter medicines; hence the bark is uſed with advantage in the cure of ulcers.

6. Bitter medicines ſtrengthen digeſtion by promoting the abſorption of chyle; hence the introduction of hop into the potation uſed at our meals, which as a medicine may be taken advantageouſly, but, like other unneceſſary ſtimuli, muſt be injurious as an article of our daily diet.

The hop may perhaps in ſome degree contribute to the production of gravel in the kidneys, as our intemperate wine-drinkers are more ſubject to the gout, and ale-drinkers to the gravel; in the formation of both which diſeaſes, there can be no doubt, but that the alcohol is the principal, if not the only agent.

7. Vomits greatly increaſe the abſorption from the cellular membrane, as ſquill, and foxglove. The ſquill ſhould be given in the doſe of a grain of the dried root every hour, till it operates up-

wards and downwards. Four ounces of the freſh leaves of the foxglove ſhould be boiled from two pounds of water to one, and half an ounce of the decoction taken every two hours for four or more doſes. This medicine by ſtimulating into inverted action the abſorbents of the ſtomach, increaſes the direct action of the cellular lymphatics.

Another more convenient way of aſcertaining the doſe of foxglove is by making a ſaturated tincture of it in proof ſpirit; which has the two-fold advantage of being invariable in its original ſtrength, and of keeping a long time as a ſhop-medicine without loſing any of its virtue. Put two ounces of the leaves of purple foxglove, digitalis purpurea, nicely dried, and coarſely powdered, into a mixture of four ounces of rectified ſpirit of wine and four ounces of water; let the mixture ſtand by the fire-ſide twenty-four hours frequently ſhaking the bottle, and thus making a ſaturated tincture of digitalis; which muſt be poured from the ſediment or paſſed through filtering paper.

Some perſon has lately objected to the quantity of the dried leaves of digitalis uſed in this tincture as an unneceſſary expenſe; not knowing that the plant grows ſpontaneouſly by cart-loads in all ſandy ſituations, and not recollecting that the certainty of procuring this medicine at all times of the year, and from all ſhops of the ſame degree of ſtrength, is a circumſtance of great importance.

As the ſize of a drop is greater or leſs according to the ſize of the rim of the phial from which it is dropped, a part of this ſaturated tincture is then directed to be put into a two-ounce phial, for the purpoſe of aſcertaining the ſize of the drop. Thirty drops of this tincture are directed to be put into an ounce of mint-water for a draught to be taken twice or thrice a day, till it reduces the anaſarca of the limbs, or removes the difficulty of breathing in hydrothorax, or till it induces ſickneſs. And if theſe do not occur in two or three days, the doſe muſt be gradually increaſed to forty or ſixty drops, or further.

A lady, who was 92 years of age, was ſeized ſuddenly, early in the morning, with great difficulty of reſpiration, which continued in greater or leſs degree in ſpite of many medicines for two or three weeks. Her legs were then become oedematous, and ſhe could not lie down horizontally. On taking thirty drops of the ſaturated tincture of digitalis from a two-ounce phial twice a day, ſhe became free from the difficult reſpiration, and her legs became leſs ſwelled, in two or three days. She has repeated this medicine about once a month for more than a year, with tincture of bark at intervals, and half a grain of opium at night, and retains a tolerable ſtate of health.

From the great ſtimulus of this medicine the ſtomach is rendered torpid with conſequent ſickneſs, which continues many hours and even days, owing to the great exhauſtion of its ſenſorial power of irritation; and the action of the heart and arteries becomes feeble from the deficient excitement of the ſenſorial power of aſſociation; and laſtly, the abſorbents of the cellular membrane act more violently in conſequence of the accumulation of the ſenſorial power of aſſociation in the torpid heart and arteries, as explained in Suppl. I. 12.

A circumſtance curiouſly ſimilar to this occurs to ſome people on ſmoking tobacco for a ſhort time, who have not been accuſtomed to it. A degree of ſickneſs is preſently induced, and the pulſations of the heart and arteries become feeble for a ſhort time, as in the approach to fainting, owing to the direct ſympathy between theſe and the ſtomach, that is from defect of the excitement of the power of aſſociation. Then there ſucceed a tingling, and heat, and ſometimes ſweat, owing to the increaſed action of the capillaries, or perſpirative and mucous glands; which are occaſioned by the accumulation of the ſenſorial power of aſſociation by the weaker action of the heart and arteries, which now increaſes the action of the capillaries.

8. Another method of increaſing abſorption

from the cellular membrane is by warm air, or by warm ſteam. If the ſwelled legs of a dropſical patient are encloſed in a box, the air of which is made warm by a lamp or two, copious ſweats are ſoon produced by the increaſed action of the capillary glands, which are ſeen to ſtand on the ſkin, as it cannot readily exhale in ſo ſmall a quantity of air, which is only changed ſo faſt as may be neceſſary to permit the lamps to burn. At the ſame time the lymphatics of the cellular membrane are ſtimulated by the heat into greater action, as appears by the ſpeedy reduction of the tumid legs.

It would be well worth trying an experiment upon a perſon labouring under a general anaſarca by putting him into a room filled with air heated to 120 or 130 degrees, which would probably excite a great general diaphoreſis, and a general cellular abſorption both from the lungs and every other part. And that air of ſo great heat may be borne for many minutes without great inconvenience was ſhewn by the experiments made in heated rooms by Dr. Fordyce and others. Philoſ. Tranſ.

Another experiment of uſing warmth in anaſarca, or in other diſeaſes, might be by immerſing the patient in warm air, or in warm ſteam, received into an oil-ſkin bag, or bathing-tub of tin, ſo managed, that the current of warm air or ſteam ſhould paſs round and cover the whole of the body except the head, which might not be expoſed to it; and thus the abſorbents of the lungs might be induced to act more powerfully by ſympathy with the ſkin, and not by the ſtimulus of heat. See Uſes of Warm Bath, Art. II. 2. 2. 1.

A warm ſaline pediluvium has often been uſed with ſucceſs to remove ſwellings of the legs from deficient action of the abſorbents of the lower extremities; the quantity of ſea-ſalt ſhould be about one thirtieth part of the water, which with about one eightieth part of ſulphuric magneſian ſalt, called magneſia vitriolata, or bitter cathartic ſalt, conſtitutes the medium ſtrength of the ſea-water round this iſland, according to the experiments of Mr. Brownrig. In ſuch a pediluvium the ſwelled legs ſhould be immerſed for half an hour every night for a fortnight, at the heat of about 96 or 98 degrees.

Dr. Reid, in a Treatiſe on Sea-bathing; Cadell and Davis, London; recommends an univerſal warm-bath of ſea-water, in œdematous ſwellings, apparently with great ſucceſs, and well adviſes friction to be diligently uſed in the bath on the tumid limbs, always rubbing them from their extremities towards the trunk of the body, and not the contrary way; as this muſt moſt facilitate the progreſs of the fluids in the abſorbent ſyſtem; though theſe veſſels are furniſhed with valves to prevent its return. In theſe baths the ſtimulus of the ſalt is added to that of the heat. See Art. II. 2. 2. 1.

9. Another method of increaſing abſorption from the cellular membrane, which has been uſed in dropſies, has been by the great or total abſtinence from fluids. This may in ſome degree be uſed advantageouſly in ſubjects of too great corpulency, but if carried to exceſs may induce fevers, and greater evils than it is deſigned to counteract, beſides the perpetual exiſtence of a painful thirſt. In moſt dropſies the thirſt already exiſting ſhews, that too little diluent fluid, and not too much, is preſent in the circulation.

IV. 1. Venous abſorption. Cellery, water-creſſes, cabbages, and many other vegetables of the claſs tetradynamia, do not increaſe the heat of the body (except thoſe, the acrimony of which approaches to corroſion), and hence they ſeem alone, or principally, to act on the venous ſyſtem; the extremities of which we have ſhewn are abſorbents of the red blood, after it has paſſed the capillaries and glands.

2. In the ſea-ſcurvy and petechial fever the veins do not perfectly perform this office of abſorption; and hence the vibices are occaſioned by blood ſtagnating at their extremities, or extravaſated into the cellular membrane. And this claſs

of vegetables, ſtimulating the veins to perform their natural abſorption, without increaſing the energy of the arterial action, prevents future petechiæ, and may aſſiſt the abſorption of the blood already ſtagnated, as ſoon as its chemical change renders it proper for that operation.

3. The fluids, which are extravaſated, and received into the cells of the cellular membrane, ſeem to continue there for many days, ſo as to undergo ſome chemical change, and are then taken up again by the mouths of the cellular abſorbents. But the new veſſels produced in inflamed parts, as they communicate with the veins, are probably abſorbed again by the veins along with the blood which they contain in their cavities. Hence the blood, which is extravaſated in bruiſes of vibices, is gradually many days in diſappearing; but after due evacuations the inflamed veſſels on the white of the eye, if any ſtimulant lotion is applied, totally diſappear in a few hours.

Amongſt abſorbents affecting the veins we ſhould therefore add the external application of ſtimulant materials; as of vinegar, which makes the lips pale on touching them. Friction, and electricity.

4. Hemorrhages are of two kinds, either arterial,

rial, which are attended with inflammation; or venous, from a deficiency in the abſorbent power of this ſet of veſſels. In the former caſe the torpentia are efficacious; in the latter ſteel, opium, alum, and all the tribe of ſorbentia, are uſed with ſucceſs.

5. Sydenham recommends vegetables of the claſs tetradynamia in rheumatic pains left after the cure of intermittents. Theſe pains are perhaps ſimilar to thoſe of the ſea-ſcurvy, and ſeem to ariſe from want of abſorption in the affected part, and hence are relieved by the ſame medicines.

V. 1. Inteſtinal abſorption. Some aſtringent vegetables, as rhubarb, may be given in ſuch doſes as to prove cathartic; and, after a part of it is evacuated from the body, the remaining part augments the abſorption of the inteſtines; and acts, as if a ſimilar doſe had been exhibited after the operation of any other purgative. Hence 4 grains of rhubarb ſtrengthen the bowels, 30 grains firſt empty them.

2. The earthy ſalts, as alum, increaſe the inteſtinal abſorption, and hence induce conſtipation in their uſual doſe; alum is ſaid ſometimes to cure intermittents, perhaps when their ſeat is in the inteſtines, when other reme-

dies have failed. It is uſeful in the diabetes, by exciting the abſorbents of the bladder into their natural action; and combined with reſin is eſteemed in the fluor albus, and in gleets. Limeſtone or chalk, and probably gypſum, poſſeſs effects in ſome degree ſimilar, and increaſe the abſorption of the inteſtines; and thus in certain doſes reſtrain ſome diarrhœas, but in greater doſes alum I ſuppoſe will act as a cathartic. Five or ten grains produce conſtipation, 20 or 30 grains are either emetic or cathartic.

3. Earth of alum, tobacco-pipe clay, marl, Armenian bole, lime, crab's eyes or claws, and calcined hartſhorn, or bone aſhes, reſtrain fluxes; either mechanically by ſupplying ſomething like mucilage, or oil, or rollers to abate the friction of the aliment over inflamed membranes; or by increaſing their abſorption. The two laſt conſiſt of calcareous earth united to phoſphoric acid, and the Armenian bole and marl may contain iron. By the conſent between the inteſtines and the ſkin 20 grains of Armenian bole given at going into bed to hectic patients will frequently check their tendency to ſweat as well as to purge, and the more certainly if joined with one grain of opium.

VI. 1. Abſorption from the liver, ſtomach, and other viſcera. When inflammations of the liver are ſubdued to a certain degree by veneſection, with calomel and other gentle purges, ſo that the arterial energy becomes weakened, four or eight grains of iron-filings, or of ſalt of ſteel, with the Peruvian bark, have wonderful effect in curing the cough, and reſtoring the liver to its uſual ſize and ſanity; which it ſeems to effect by increaſing the abſorption of this viſcus. The ſame I ſuppoſe happens in reſpect to the tumours of other viſcera, as of the ſpleen, or pancreas, ſome of which are frequently enlarged in agues.

2. Hemorrhages from the noſe, rectum, kidneys, uterus, and other parts, are frequently attendant on diſeaſed livers; the blood being impeded in the vena portarum from the decreaſed power of abſorption, and in conſequence of the increaſed ſize of this viſcus. Theſe hemorrhages after veneſection, and a mercurial cathartic, are moſt certainly reſtrained by ſteel alone, or joined with an opiate; which increaſe the abſorption, and diminiſh the ſize of the liver.

Chalybeates may alſo reſtrain theſe hemorrhages by their promoting venous abſorption, though they exert their principal effect upon the liver. Hence alſo opiates, and bitters, and vitriolic acid, are advantageouſly uſed along with them. It muſt be added that ſome hemorrhages recur by periods like the paroxyſms of intermittent fevers, and are thence cured by the ſame treatment.

3. The jaundice is frequently cauſed by the inſipidity of the bile, which does not ſtimulate the gall-bladder and bile-ducts into their due action; hence it ſtagnates in the gall-bladder, and produces a kind of cryſtallization, which is too large to paſs into the inteſtines, blocks up the bile-duct, and occaſions a long and painful diſeaſe. A paralyſis of the bile-duct produces a ſimilar jaundice, but without pain.

4. Worms in ſheep called *flukes* are owing to the dilute ſtate of the bile; hence they originate in the inteſtines, and thence migrate into the biliary ducts, and corroding the liver produce ulcers, cough, and hectic fever, called the rot. In human bodies it is probable the inert ſtate of the bile is one cauſe of the production of worms; which inſipid ſtate of the bile is owing to deficient abſorption of the thinner parts of it; hence the pale and bloated complexion, and ſwelled upper lip, of wormy children, is owing to the concomitant deficiency of abſorption from the cellular membrane. Salt of ſteel, or the ruſt of it, or filings of it, with bitters, increaſe the acrimony of the bile by promoting the abſorption of its aqueous part; and hence deſtroy worms, as well by their immediate action on the inteſtines,

as on the worms themſelves. The cure is facilitated by premiſing a purge with calomel. See Claſs I. 2. 3. 9.

5. The chloroſis is another diſeaſe owing to the deficient action of the abſorbents of the liver, and perhaps in ſome degree alſo to that of the ſecretory veſſels, or glands, which compoſe that viſcus. Of this the want of the catamenia, which is generally ſuppoſed to be a cauſe, is only a ſymptom or conſequence. In this complaint the bile is deficient perhaps in quantity, but certainly in acrimony, the thinner parts not being abſorbed from it. Now as the bile is probably of great conſequence in the proceſs of making the blood; it is on this account that the blood is ſo deſtitute of red globules; which is evinced by the great paleneſs of theſe patients. As this ſerous blood muſt exert leſs ſtimulus on the heart, and arteries, the pulſe in conſequence becomes quick as well as weak, as explained in Sect. XII. 1. 4.

The quickneſs of the pulſe is frequently ſo great and permanent, that when attended by an accidental cough, the diſeaſe may be miſtaken for hectic fever; but is cured by chalybeates, and bitters exhibited twice a day; with half a grain of opium, and a grain of aloe every night; and the expected catamenia appears in conſequence of a reſtoration of the due quantity of red blood. This and the two former articles approach to the diſeaſe termed paralyſis of the liver. Sect. XXX. 4.

6. It ſeems paradoxical, that the ſame treatment with chalybeates, bitters, and opiates, which produces menſtruation in chlorotic patients, ſhould repreſs the too great or permanent menſtruation, which occurs in weak conſtitutions at the time of life when it ſhould ceaſe. This complaint is a hemorrhage owing to the debility of the abſorbent power of the veins, and belongs to the paragraph on venous abſorption above deſcribed, and is thence curable by chalybeates, alum, bitters, and particularly by the exhibition of a grain of opium every night with five grains of rhubarb.

As ſteel is ſoluble in the gaſtric acid, perhaps the beſt way of giving it may be in fine filings, or in a ſteel-powder prepared in the following manner: diſſolve green vitriol in water, add a few bits of iron to the ſolution, to precipitate any copper which may be accidentally in it; precipitate this ſolution by ſalt of tartar, kali preparatum. Add to the precipitate two or three times its quantity of charcoal powder, mix and put them into a crucible covered with a tile, and give them a red heat for an hour. An impalpable powder of iron will be produced, which ought all of it to obey the magnet.

7. Metallic ſalts ſupply us with very powerful

remedies for promoting abſorption in dropſical caſes; which frequently are cauſed by enlargement of the liver. Firſt, as they may be given in ſuch quantities as to prove ſtrongly cathartic, of which more will be ſaid in the article on invertentia; and then, when their purgative quality ceaſes, like the effect of rhubarb, their abſorbent quality continues to act. The ſalts of mercury, ſilver, copper, iron, zinc, antimony, have all been uſed in the dropſy; either ſingly for the former purpoſe, or united with bitters for the latter, and occaſionally with moderate but repeated opiates.

8. From a quarter of a grain to half a grain of blue vitriol given every four or ſix hours, is ſaid to be very efficacious in obſtinate intermittents; which alſo frequently ariſe from an enlarged viſcus, as the liver or ſpleen, and are thence owing to the deficient abſorption of the lymphatics of that viſcus. A quarter of a grain of white arſenic, as I was informed by a ſurgeon of the army, cures a quartan ague with great certainty, if it be given an hour before the expected fit. This doſe he ſaid was for a robuſt man, perhaps one eighth of a grain might be given and repeated with greater ſafety and equal efficacy.

Dr. Fowler has given many ſucceſsful caſes in his treatiſe on this ſubject. He prepares it by boiling ſixty-four grains of white arſenic in a Florence flaſk along with as much pure vegetable

table fixed alcali in a pint of diſtilled water till they are diſſolved, and then adding as much diſtilled water as will make the whole exactly ſixteen ounces. Hence there are four grains of arſenic in every ounce of the ſolution. This ſhould be put into a phial of ſuch a ſize of the edge of its aperture, that ſixty drops may weigh one dram, which will contain half a grain of arſenic. To children from two years old to four he gives from two to five drops three or four times a day. From five years old to ſeven, he directs ſeven or eight drops. From eight years old to twelve, he directs from ſeven to ten drops. From thirteen years old to eighteen he directs from ten to twelve drops. From eighteen upwards, twelve drops. In ſo powerful a medicine it is always prudent to begin with ſmaller doſes, and gradually to increaſe them.

A ſaturated ſolution of arſenic in water is preferable I think to the above operoſe preparation of it; as no error can happen in weighing the ingredients, and it more certainly therefore poſſeſſes an uniform ſtrength. Put much more white arſenic reduced to powder into a given quantity of diſtilled water, than can be diſſolved in it. Boil it for half an hour in a Florence flaſk, or in a tin ſauce-pan; let it ſtand to ſubſide, and filter it through paper. My friend Mr. Greene, a ſurgeon at Breewood in Staffordſhire, aſſured me, that he had cured in one ſeaſon agues without number with this ſaturated ſolution; that he found ten drops from a two-ounce phial given thrice a day was a full doſe for a grown perſon, but that he generally began with five.

9. The manner, in which arſenic acts in curing intermittent fevers cannot be by its general ſtimulus, becauſe no intoxication or heat follows the uſe of it; nor by its peculiar ſtimulus on any part of the ſecreting ſyſtem, ſince it is not in ſmall doſes ſucceeded by any increaſed evacuation, or heat, and muſt therefore exert its power, like other articles of the ſorbentia, on the abſorbent ſyſtem. In what manner it deſtroys life ſo ſuddenly is difficult to underſtand, as it does not intoxicate like many vegetable poiſons, nor produce fevers like contagious matter. When applied externally it ſeems chemically to deſtroy the part like other cauſtics. Does it chemically deſtroy the ſtomach, and life in conſequence? or does it deſtroy the action of the ſtomach by its great ſtimulus, and life in conſequence of the ſympathy between the ſtomach and the heart? This laſt appears to be the moſt probable mode of its operation.

The ſucceſs of arſenic in the cure of intermittent fevers I ſuſpect to depend on its ſtimulating the ſtomach into ſtronger action, and thus, by the aſſociation of this viſcus with the heart and arteries, preventing the torpor of any part of the ſanguiferous ſyſtem. I was led to this concluſion from the following conſiderations.

Firſt. The effects of arſenic given a long time internally in ſmall doſes, or when uſed in larger quantities externally, ſeem to be ſimilar to thoſe of other great ſtimuli, as of wine or alcohol. Theſe are a bloated countenance, ſwelled legs, hepatic tumours, and dropſy, and ſometimes eruptions on the ſkin. The former of theſe I have ſeen, where arſenic has been uſed externally for curing the itch; and the latter appears on evidence in the famous trial of Miſs Blandy at Chelmsford, about forty years ago.

Secondly. I ſaw an ague cured by arſenic in a child, who had in vain previouſly taken a very large quantity of bark with great regularity. And another caſe of a young officer, who had lived intemperately, and laboured under an intermittent fever, and had taken the bark repeatedly in conſiderable quantities, with a grain of opium at night, and though the paroxyſms had been thrice thus for a time prevented, they recurred in about a week. On taking five drops of a ſaturated ſolution of arſenic thrice a day the paroxyſms ceaſed, and returned no more, and at the ſame time his appetite became much improved.

Thirdly. A gentleman about ſixty-five years of age had for about ten years been ſubject to an intermittent pulſe, and to frequent palpitations of his heart. Lately the palpitations ſeemed to obſerve irregular periods, but the intermiſſion of every third or fourth pulſation was almoſt per-

petual.

petual. On giving him four drops of a ſaturated ſolution of arſenic from a two-ounce phial almoſt every four hours for one day, not only the palpitation did not return, but the intermiſſion ceaſed entirely, and did not return ſo long as he took the medicine, which was three or four days.

Now as when the ſtomach has its action much weakened by an over-doſe of digitalis, the pulſe is liable to intermit, this evinces a direct ſympathy between theſe parts of the ſyſtem; and as I have repeatedly obſerved, that when the pulſe begins to intermit in elderly people, that an eructation from the ſtomach, voluntarily produced, will prevent the threatened ſtop of the heart; I am induced to think, that the torpid ſtate of the ſtomach, at the inſtant of the production of air occaſioned by its weak action, cauſed the intermiſſion of the pulſe. And that arſenic in this caſe, as well as in the caſes of agues above mentioned, produced its effects by ſtimulating the ſtomach into more powerful action; and that the equality of the motions of the heart was thus reſtored by increaſing the excitement of the ſenſorial power of aſſociation. See Sect. XXV. 17. Claſs IV. 2. 1. 18.

Arſenic has lately been recommended in the hooping cough, tuſſis convulſiva, by Mr. Simmons, ſurgeon of Mancheſter, which he aſſerts to be attended with the moſt ſalutary effects, moderating the diſeaſe in a few days, and curing it generally in a fortnight. He has given it to children of a year old with ſafety, in the doſes recommended by Dr. Fowler, whoſe ſolution he uſed, but ſeems to have uſed veneſection and emetics occaſionally, and recommends, after the ſolution has been omitted for a week, to repeat it, to prevent a relapſe. Annals of Medicine, 1797.

10. Where arſenic has been given as poiſon, it may be diſcovered in the contents of the ſtomach by the ſmell like garlic, when a few grains of it are thrown on a red-hot iron. 2. If a few grains are placed between two plates of copper, and ſubjected to a red heat, the copper becomes whitened. 3. Diſſolve arſenic in water along with vegetable alcali, add to this a ſolution of blue vitriol in water, and the mixture becomes of a fine green, which gradually precipitates, as diſcovered by Bergman. 4. Where the quantity is ſufficient, ſome wheat may be ſteeped in a ſolution of it, which given to ſparrows or chickens will deſtroy them.

VII. 1. Abſorption of the matter from venereal ulcers. No ulcer can heal, unleſs the abſorption from it is as great as the depoſition in it. The preparations or oxydes of mercury in the cure of the venereal diſeaſe ſeem to act by their increaſing the abſorption of the matter in the ulcers it occaſions; and that whether they are taken into the ſtomach, or applied on the ſkin, or on the ſurface of the ulcers. And this in the

ſame

ſame manner as ſugar of lead, or other metallic oxydes, promote ſo rapidly the healing of other ulcers by their external application; and probably when taken internally, as ruſt of iron given to children affected with ſcrofulous ulcers contributes to heal them, and ſolutions of lead were once famous in phthiſis.

The matter depoſited in large abſceſſes does not occaſion hectic fever, till it has become oxygenated by being expoſed to the open air, or to the air through a moiſt membrane; the ſame ſeems to happen to other kinds of matter, which produce fever, or which occaſion ſpreading ulcers, and are thence termed contagious. See Claſs II. 1. 3. II. 1. 5. II. 1. 6. 6. This may perhaps occur from theſe matters not being generally abſorbed, till they become oxygenated; and that it is the ſtimulus of the acid thus formed by their union with oxygen, which occaſions their abſorption into the circulation, and the fever, which they then produce. For though collections of matter, and milk, and mucus, are ſometimes ſuddenly abſorbed during the action of emetics or in ſea-ſickneſs, they are probably eliminated from the body without entering the circulation; that is, they are taken up by the increaſed action of one lymphatic branch, and evacuated by the inverted action of ſome other lymphatic branch, and thus carried off by ſtool or urine.

2. But as the matter in large abſceſſes is in general not abſorbed, till it becomes by ſome means expoſed to air, there is reaſon to conclude, that the ſtimulus of this new combination of the matter with oxygen occaſions its abſorption; and that hence the abſorption of matter in ulcers of all kinds, is ſtill more powerfully effected by the external application or internal uſe of metallic oxydes; which are alſo acids conſiſting of the metal united with oxygen; and laſtly, becauſe venereal ulcers, and thoſe of itch, and tinea, will not heal without ſome ſtimulant application; that is, the ſecretion of matter in them continues to be greater, than the abſorption of it; and the ulcers at the ſame time continue to enlarge, by the contagion affecting the edges of them; that is, by the ſtimulus of the oxygenated matter ſtimulating the capillary veſſels in its vicinity into actions ſimilar to thoſe of the ulcer, which produces it.

This effect of the oxydes of mercury occurs, whether ſalivation attends its uſe or not. Salivation is much forwarded by external warmth, when mercury is given to promote this ſecretion; but as the cure of venereal complaints depends on its abſorbent quality, the act of ſalivation is not neceſſary or uſeful. A quarter of a grain of good corroſive ſublimate twice a day will ſeldom fail of curing the moſt confirmed pox; and will as ſeldom ſalivate, if the patient be kept cool. A quarter of a grain thrice a day I believe to be infallible, if it be good ſublimate.

Mercury alone when ſwallowed does not act beyond the inteſtines; its active preparations are the ſalts formed by its union with the various acids, as mentioned in the catalogue. Its union with the vegetable acid, when triturated with manna, is ſaid to compoſe Keyſer's Pill. Triturated with gum arabic it is much recommended by Plenck; and triturated with ſugar and a little eſſential oil, as directed in a former Edinburgh Diſpenſatory, it probably forms ſome of the ſyrups ſold as noſtrums.

United with ſulphur it ſeldom enters the circulation, as when cinnabar, or æthiops mineral, is taken inwardly. But united with fat and rubbed on the ſkin, it is readily abſorbed. I know not whether it can be united to charcoal, nor whether it has been given internally when united with animal fat; if ſix grains only of ſulphur be added to two ounces of hog's fat and ſix drachms of mercury, they are ſaid to unite with much leſs labour of trituration, than the hog's fat and mercury alone.

VIII. 1. Abſorptions in general are increaſed by inanition; hence the uſe of evacuations in the cure of ulcers. Dr. Jurin abſorbed in one night, after a day's abſtinence and exerciſe, eighteen ounces from the atmoſphere in his chamber; and every one muſt have obſerved, how ſoon his ſheets became dry, after having been moiſtened by ſweat, if he throws off part of the bed-clothes to cool himſelf; which is owing to the increaſed cutaneous abſorption after the evacuation by previous ſweat.

2. Now as opium is an univerſal ſtimulant, as explained in the article of Incitantia, it muſt ſtimulate into increaſed action both the ſecretory ſyſtem, and the abſorbent one; but after repeated evacuation by veneſection, and cathartics, the abſorbent ſyſtem is already inclined to act more powerfully; as the blood-veſſels being leſs diſtended, there is leſs reſiſtance to the progreſs of the abſorbed fluids into them. Hence after evacuations opium promotes abſorption, if given in ſmall doſes, much more than it promotes ſecretion; and is thus eminently of ſervice at the end of inflammations, as in pleuriſy, or peripneumony, in the doſe of four or five drops of the tincture, given before the acceſs of the evening paroxyſm; which I have ſeen ſucceed even when the riſus ſardonicus has exiſted. Some convulſions may originate in the want of the abſorption of ſome acrid ſecretion, which occaſions pain; hence theſe diſeaſes are ſo much more certainly relieved by opium after veneſection or other evacuations.

IX. 1. Abſorption is increaſed by the calces or ſolutions of mercury, lead, zinc, copper, iron, externally applied; and by arſenic, and by ſulphur, and by the application of bitter vegetables in fine powder. Thus an ointment conſiſting of mercury and hog's fat rubbed on the ſkin cures venereal ulcers; and many kinds of herpetic eruptions are removed by an ointment conſiſting of ſixty grains of white precipitate of mercury and an ounce of hog's fat.

2. The tumours about the necks of young people are often produced by the abſorption of a ſaline or acrid material, which has been depoſited from eruptions behind the ears, owing to deficient abſorption in the ſurface of the ulcer, but which on running down on the ſkin below becomes abſorbed, and ſwells the lymphatic glands of the neck; as the variolous matter, when inſerted into the arm, ſwells the gland of the axilla. Sometimes the perſpirative matter produced behind the ears becomes putrid from the want of daily waſhing them, and may alſo cauſe by its abſorption the tumours of the lymphatics of the neck. In the former caſe the application of a cerate of lapis calaminaris, or of ceruſſa in dry powder, or of rags dipped in a ſolution of ſugar of lead, increaſes the abſorption in the ulcers, and prevents the effuſion of the

ſaline part of the ſecreted material. The latter is to be prevented by cleanlineſs.

After the eruptions or ulcers are healed a ſolution of corroſive ſublimate of one grain to an ounce of water applied for ſome weeks behind the ear, and amongſt the roots of the hair on one ſide of the head, where the mouths of the lymphatics of the neck open themſelves, frequently removes theſe tumours.

3. Linen rags moiſtened with a ſolution of half an ounce of ſugar of lead to a pint of water applied on the eryſipelas on anaſarcous legs, which have a tendency to mortification, is more efficacious than other applications. White vitriol ſix grains diſſolved in one ounce of roſe-water removes inflammations of the eyes after evacuation more certainly than ſolutions of lead. Blue vitriol two or three grains diſſolved in an ounce of water cures ulcers in the mouth, and other mucous membranes, and a ſolution of arſenic externally applied cures the itch, but requires great caution in the uſe of it. See Claſs II. 1. 5. 6.

A feeble old man with ſwelled legs had an eryſipelas on both of them; to one of theſe legs a fine powder of Peruvian bark was applied dry, and renewed twice a day; on the other linen rags moiſtened with a ſolution of ſaccharum ſaturni were applied, and renewed twice a day;

and it was obſerved, that the latter healed much ſooner than the former.

As the external application of calx of lead ſtimulates inflamed parts very violently, if it be applied too early, before the veſſels are emptied by evacuations, or by the continuance of the diſeaſe, it is liable to increaſe the inflammation, or to induce mortification, as in ophthalmy; and in a caſe, which was related to me of a perſon who much pricked his legs amongſt gorſe, which, on the application of Goulard's ſolution of lead, mortified with extenſive ſloughs. But where the ſyſtem is previouſly emptied, there is leſs reſiſtance to the progreſs of abſorbed fluids; and the ſtimulus of lead then increaſes the action of the abſorbent ſyſtem more than of the ſecerning ſyſtem, and the inflamed part preſently diſappears.

4. Bitter vegetables, as the Peruvian bark, quilted between two ſhirts, or ſtrewed in their beds, will cure the ague in children ſometimes. Iron in ſolution, and ſome bitter extract, as in the form of ink, will cure one kind of herpes called the ringworm. And I have ſeen ſeven parts of bark in fine powder mixed with one part of ceruſe, or white lead, in fine powder, applied dry to ſcrofulous ulcers, and renewed daily, with great advantage.

5. To theſe ſhould be added electric ſparks

and ſhocks, which promote the abſorption of the veſſels in inflamed eyes of ſcrofulous children; and diſperſe, or bring to ſuppuration, ſcrofulous tumours about the neck. For this laſt purpoſe ſmart ſhocks ſhould be paſſed through the tumours only, by encloſing them between two braſs knobs communicating with the external and internal coating of a charged phial. See Art. II. 2. 2. 2.

X. 1. Bandages increaſe abſorption, if they are made to fit nicely on the part; for which purpoſe it is neceſſary to ſpread ſome moderately adheſive plaſter on the bandage, and to cut it into tails, or into ſhreds two inches wide; the ends are to be wrapped over each other; and it muſt be applied when the part is leaſt tumid, as in the morning before the patient riſes, if on the lower extremities. The emplaſtrum de minio made to cover the whole of a ſwelled leg in this manner, whether the ſwelling is hard, which is uſually termed ſcorbutic; or more eaſily compreſſible, as in anaſarca, reduces the limb in two or three days to its natural ſize; for this purpoſe I have ſometimes uſed carpenter's glue, mixed with one twentieth part of honey to prevent its becoming too hard, inſtead of a reſinous plaſter; but the minium plaſter of the ſhops is in general to be preferred. Nothing ſo much facilitates the cure of ulcers in the legs, as covering the whole limb from the toes to the knee with ſuch a plaſter bandage; which increaſes the power of abſorption in the ſurface of the ſore.

2. The lymph is carried along the abſorbent veſſels, which are replete with valves, by the intermitted preſſure of the arteries in their neighbourhood. Now if the external ſkin of the limb be lax, it riſes, and gives way to the preſſure of the arteries at every pulſation; and thence the lymphatic veſſels are ſubject to the preſſure of but half the arterial force. But when the external ſkin is tightened by the ſurrounding bandage, and thence is not elevated by the arterial diaſtole, the whole of this power is exerted in compreſſing the lymphatic veſſels, and carrying on the lymph already abſorbed; and thence the abſorbent power is ſo amazingly increaſed by bandage nicely applied. Pains are ſometimes left in the fleſhy parts of the thighs or arms, after the inflammation is gone, in the acute rheumatiſm, or after the patient is too weak for further evacuation; in this caſe after internal abſorbent medicines, as the bark, and opiates, have been uſed in vain, I have ſucceſsfully applied a plaſter-bandage, as above deſcribed, ſo as to compreſs the pained part.

Since the above was written, Mr. Baynton, an ingenious ſurgeon of Briſtol, has publiſhed "A Method of Treating Ulcers of the Legs," ſold by

Robinſon, London. In which he endeavours to bring the lips of thoſe ulcers nearer together by means of ſlips of adheſive plaſter, as above deſcribed; which ſeems to have been attended with great ſucceſs, without confinement of the patient. See Sect. XXXIII. 3. 2.

But when ſlips of adheſive plaſter are put over a wound ſo as to bring the edges of it together nearly, or quite, into contact with each other, the part is at the ſame time covered, as the ſlips of adheſive plaſter are applied, from the eye of the ſurgeon. I have therefore adviſed two tin plates a little longer than the wound, and about half an inch broad, to be faſtened to the ends of the pieces of adheſive plaſter, and applied one on each lip of the wound or ulcer; and then by a narrow ſlip of adheſive plaſter applied at each end of theſe tins, they may be drawn together, and the whole lips of the wound may be ſeen at the ſame time by the ſurgeon; and then a compreſs of thin lead, or of linen, may be applied by other ſtrips of plaſter ſo as to heal recent wounds, and even ulcers, without ſcarcely any unevenneſs or width of the ſcar.

XI. 1. We ſhall conclude by obſerving, that the ſorbentia ſtrengthen the whole habit by preventing the eſcape of the fluid part of the ſecretions out of the body, before it has given up as much nouriſhment, as it is capable; as the liquid part of the ſecretion of urine, ſweat, ſaliva, and of all other ſecretions, which are poured into receptacles. Hence they have been ſaid to brace the body, and been called tonics, which are mechanical terms not applicable to the living bodies of animals; as explained in Sect. XXXII. 3. 2.

2. A continued uſe of bitter medicines for years together, as of Portland's powder, or of the bark, is ſuppoſed to induce apoplexy, or other fatal diſeaſes. Two caſes of this kind have fallen under my obſervation; the patients were both rather intemperate in reſpect to the uſe of fermented liquors, and one of them had been previouſly ſubject to the gout. As I believe the gout generally originates from a torpor of the liver, which, inſtead of being ſucceeded by an inflammation of it, is ſucceeded by an inflammation of ſome of the joints; or by a pimpled face, which is another mode, by which the diſeaſe of the liver is terminated: I conceive, that the daily uſe of bitter medicines had in theſe patients prevented the removal of a gouty inflammation from the liver to the membranes of the joints of the extremities, or to the ſkin of the face, by preventing the neceſſary torpor of theſe parts previous to the inflammation of them; in the ſame manner as cold fits of fever are prevented by the ſame medicines; and, as I believe, the returns

turns of the gout have ſome times for two or three years been prevented by them.

One of theſe patients died of the apoplexy in a few hours; and the other of an inflammation of the liver, which I believe was called the gout, and in conſequence was not treated by veneſection, and other evacuations. Hence it appears, that the daily uſe of hop in our malt liquor muſt add to the noxious quality of the ſpirit in it, when taken to exceſs, and contribute to the production of apoplexy, or inflammation of the liver.

III. CATALGUE OF THE SORBENTIA.

I. Sorbentia affecting the ſkin.
    1. Acid of vitriol, of ſea-ſalt, lemons, ſloes, prunus ſpinoſa, crabs, pyrus, quince, pyrus cydonia, opium.
    2. Externally calx of zinc, of lead, or of mercury.
II. Sorbentia affecting the mucous membranes.
    1. Juice of ſloes, crabs, Peruvian bark, cinchona, opium.
    2. Externally blue vitriol.
III. Sorbentia affecting the cellular membrane.
    1. Peruvian bark, wormwoods, artemiſia maritima,

maritima, artemiſia abſynthium, wormſeed, artemiſia ſantonicum, chamomile, anthemis nobilis, tanſey, tanacetum, bogbean, menyanthes trifoliata, centaury, gentiana centaurium, gentian, gentiana lutea, artichoke-leaves, cynara ſcolymus, hop, humulus lupulus, ſalix caprea, geum urbanum, datiſca cannabina.

2. Orange-peel, cinnamon, nutmeg, mace.
3. Vomits, ſquill, digitalis, tobacco.
4. Bath of warm air, of ſteam.

IV. Sorbentia affecting the veins.

1. Water-creſs, ſiſymbrium naſturtium aquaticum, muſtard, ſinapis, ſcurvy-graſs, cochlearia hortenſis, horſe-radiſh, cochlearia armoracia, cuckoo-flower, cardamine, dog's-graſs, dandelion, leontodon, taraxacon, cellery, apium, cabbage, braſſica.
2. Chalybeates, bitters, and opium, after ſufficient evacuation.
3. Externally vinegar, friction, electricity.

V. Sorbentia affecting the inteſtines.

1. Rhubarb, rheum palmatum, oak-galls, gallæ quercinæ, tormentilla erecta, cinquefoil, potentilla, red-roſes, uva urſi, ſimarouba.

2. Logwood, hæmatoxylum campechianum, ſuccus acaciæ, dragon's blood, terra japonica, mimoſa catechu.

3. Alum, earth of alum, Armenian bole, chalk, creta, crab's claws, chelæ cancrorum, white clay, cimolia, calcined hartſhorn, cornu cervi calcinatum, bone-aſhes.

VI. Sorbentia affecting the liver, ſtomach, and other viſcera. Ruſt of iron, filings of iron, ſalt of ſteel, ſal martis, blue vitriol, white vitriol, calomel, emetic tartar, ſugar of lead, white arſenic.

VII. Sorbentia affecting venereal ulcers. Mercury diſſolved or corroded by the following acids:

1. Diſſolved in vitriolic acid, called turpeth mineral, or hydrargyrus vitriolatus.
2. Diſſolved in nitrous acid, called hydrargyrus nitratus ruber.
3. Diſſolved in muriatic acid, mercurius corroſivus ſublimatus, or hydrargyrus muriatus.
4. Corroded by muriatic acid. Calomel.
5. Precipitated from muriatic acid, mercurius precipitatus albus, calx hydrargyri alba.
6. Corroded by carbonic acid? The black powder on crude mercury.

7. Calcined, or united with oxygen.
8. United with animal fat, mercurial ointment.
9. United with ſulphur. Cinnabar.
10. Partially united with ſulphur. Æthiops mineral.
11. Divided by calcareous earth. Hydrargyrus cum cretâ.
12. Divided by vegetable mucilage, by ſugar, by balſams.

VIII. Sorbentia affecting the whole ſyſtem. Evacuations by veneſection and catharſis, and then the exhibition of opium.

IX. Sorbentia externally applied.
1. Solutions of mercury, lead, zinc, copper, iron, arſenic; or metallic calces applied in dry powder, as ceruſſa, lapis calaminaris.
2. Bitter vegetables in decoctions and in dry powders, applied externally, as Peruvian bark, oak bark, leaves of wormwood, of tanſey, chamomile flowers or leaves.
3. Electric ſparks, or ſhocks.

X. Bandage ſpread with emplaſtrum e minio, or with carpenter's glue mixed with one twentieth part of honey.

XI. Portland's powder its continued uſe pernicious, and of hops in beer.

ART. V.

INVERTENTIA.

I. THOSE THINGS, which invert the natural order of the ſucceſſive irritative motions, are termed invertentia.

1. Emetics invert the motions of the ſtomach, duodenum, and œſophagus.

2. Violent cathartics invert the motions of the lacteals, and inteſtinal lymphatics.

3. Violent errhines invert the naſal lymphatics, and thoſe of the frontal and maxillary ſinuſes. And medicines producing nauſea, invert the motions of the lymphatics about the fauces.

4. Medicines producing much pale urine, as a certain quantity of alcohol, invert the motions of the urinary abſorbents; if the doſe of alcohol is greater, it inverts the ſtomach, producing the drunken ſickneſs.

5. Medicines producing cold ſweats, palpitation of the heart, globus hyſtericus; as violent evacuations, ſome poiſons, fear, anxiety, act by inverting the natural order of the vaſcular motions.

II. OBSERVATIONS ON THE INVERTENTIA.

I. 1. The action of vomiting ſeems originally to have been occaſioned by diſagreeable ſenſation from the diſtention or acrimony of the aliment; in the ſame manner as when any diſguſtful material is taken into the mouth, as a bitter drug, and is rejected by the retrograde motions of the tongue and lips; as explained in Claſs IV. 1. 1. 2. and mentioned in Sect. XXXV. 1. 3. Or the diſagreeable ſenſation may thus excite the power of volition, which may alſo contribute to the retrograde actions of the ſtomach and œſophagus, as when cows bring up the contents of their firſt ſtomach to remaſticate it. To either of theſe is to be attributed the action of mild emetics, which ſoon ceaſe to operate, and leave the ſtomach ſtronger, or more irritable, after their operation; owing to the accumulation of the ſenſorial power of irritation during its torpid or inverted action. Such appears to be the operation of ipecacuanha, or of antimonium tartarizatum, in ſmall doſes.

2. But there is reaſon to believe, that the ſtronger emetics, as digitalis, firſt ſtimulate the abſorbent veſſels of the ſtomach into greater action; and that the inverted motions of theſe ab-

ſorbents next occur, pouring the lymph, lately taken up, or obtained from other lymphatic branches, into the ſtomach: the quantity of which in ſome diſeaſes, as in the cholera morbus, is inconceivable. This inverted motion, firſt of the abſorbents of the ſtomach, and afterwards of the ſtomach itſelf, ſeems to originate from the exhauſtion or debility, which ſucceeds the unnatural degree of action, into which they had been previouſly ſtimulated. An unuſual defect of ſtimulus, as of food without ſpice or wine in the ſtomachs of thoſe, who have been much accuſtomed to ſpice or wine, will induce ſickneſs or vomiting; in this caſe the defective energy of the ſtomach is owing to defect of accuſtomed ſtimulus; while the action of vomiting from digitalis is owing to a deficiency of ſenſorial power, which is previouſly exhauſted by the exceſs of its ſtimulus. See Sect. XXXV. 1. 3. and Claſs IV. 1. 1. 2.

For firſt, no increaſe of heat ariſes from this action of vomiting; which always occurs, when the ſecerning ſyſtem is ſtimulated into action. Secondly, the motions of the abſorbent veſſels are as liable to inverſion as the ſtomach itſelf; which laſt, with the œſophagus, may be conſidered as the abſorbent mouth and belly of that great gland, the inteſtinal canal. Thirdly, the claſs of ſorbentia, as bitters and metallic ſalts, given in large doſes, become invertentia, and vomit,

mit, or purge. And laſtly, the ſickneſs and vomiting induced by large potations of wine, or opium, does not occur till next day in ſome people, in none till ſome time after their ingurgitation. And tincture of digitalis in the doſe of 30 or 60 drops, though applied in ſolution, is a conſiderable time before it produces its effect; though vomiting is inſtantaneouſly induced by a nauſeous idea, or a nauſeous taſte in the mouth. At the ſame time there ſeem to be ſome materials, which can immediately ſtimulate the ſtomach into ſuch powerful action, as to be immediately ſucceeded by paralyſis of it, and conſequent continued fever, or immediate death; and this without exciting ſenſation, that is, without our perceiving it. Of theſe are the contagious matter of ſome fevers ſwallowed with the ſaliva, and probably a few grains of arſenic taken in ſolution. See Suppl. I. 8. 8. Art. IV. 2. 6. 9.

3. Some branches of the lymphatic ſyſtem become inverted by their ſympathy with other branches, which are only ſtimulated into too violent abſorption. Thus, when the ſtomach and duodenum are much ſtimulated by alcohol, by nitre, or by worms, in ſome perſons the urinary lymphatics have their motion inverted, and pour that material into the bladder, which is abſorbed from the inteſtines. Hence the drunken diabetes

is produced; and hence chyle is ſeen in the urine in worm caſes.

When on the contrary ſome branches of the abſorbent ſyſtems have their motions inverted in conſequence of the previous exhauſtion of their ſenſorial power by any violent ſtimulus, other branches of it have their abſorbent power greatly increaſed. Hence continued vomiting, or violent cathartics, produce great abſorption from the cellular membrane in caſes of dropſy; and the fluids thus abſorbed are poured into the ſtomach and inteſtines by the inverted motions of the lacteals and lymphatics. See Sect. XXIX. 4. and 5.

4. The quantity of the doſe of an emetic is not of ſo great conſequence as of other medicines, as the greateſt part of it is rejected with the firſt effort. All emetics are ſaid to act with greater certainty when given in a morning, if an opiate had been given the night before. For the ſenſorial power of irritation of the ſtomach had thus been in ſome meaſure previouſly exhauſted by the ſtimulus of the opium, which thus facilitates the action of the emetic; and which, when the doſe of opium has been large, is frequently followed on the next day by ſpontaneous ſickneſs and vomitings, as after violent intoxication.

Ipecacuanha is the moſt certain in its effect from five grains to thirty; white vitriol is the moſt expeditious in its effect, from twenty grains to thirty diſſolved in warm water; but emetic tartar, antimonium tartariſatum, from one grain to four to ſane people, and from thence to twenty to inſane patients, will anſwer moſt of the uſeful purpoſes of emetics; but nothing equals the digitalis purpurea for the purpoſe of abſorbing water from the cellular membrane in the anaſarca pulmonum, or hydrops pectoris. See Art. II. 3. 7.

II. Violent cathartics. 1. Where violent cathartics are required, as in dropſies, the ſquill in dried powder made into ſmall pills of a grain, or a grain and a half, one to be given every hour till they operate briſkly, is very efficacious; or half a grain of emetic tartar diſſolved in an ounce of peppermint-water, and given every hour, till it operates. Scammony, and other ſtrong purges, are liable to produce hypercatharſis, if they are not nicely prepared, and accurately weighed, and are thence dangerous in common practice. Gamboge is uncertain in its effects, it has otherwiſe the good property of being taſteleſs; and on that account ſome preparation of it might be uſeful for children, by which its doſe could be aſcertained, and its effects rendered more uniform.

2. In inflammations of the bowels with conſti-

pation calomel, given in the doſe from ten to twenty grains after due veneſection, is moſt efficacious; and if made into very ſmall pills is not liable to be rejected by vomiting, which generally attends thoſe caſes. When this fails, a grain of aloes every hour will find its way, if the bowel is not deſtroyed; and ſometimes, I believe, if it be, when the mortification is not extenſive. If the vomiting continues after the pain ceaſes, and eſpecially if the bowels become tumid with air, which ſounds on being ſtruck with the finger, theſe patients ſeldom recover. Opiates given along with the cathartics I believe to be frequently injurious in inflammation of the bowels, though they may thus be given with advantage in the ſaturnine colic; the pain and conſtipation in which diſeaſe are owing to torpor or inactivity, and not to too great action. See Claſs I. 2. 4. 8.

III. Violent errhines and ſialagogues. 1. Turpeth mineral in the quantity of one grain mixed with ten grains of ſugar anſwers every purpoſe to be expected from errhines. Their operation is by inverting the motions of the lymphatics of the membrane, which lines the noſtrils, and the caverns of the forehead and cheeks; and may thence poſſibly be of ſervice in the hydrocephalus internus.

Some other violent errhines, as the powder of white hellebore, or Cayenne pepper, diluted with ſome leſs acrid powder, are ſaid to cure ſome cold or nervous head-achs; which may be effected by inflaming the noſtrils, and thus introducing the ſenſorial power of ſenſation, as well as increaſing that of irritation; and thus to produce violent action of the membranes of the noſtrils, and of the frontal and maxillary ſinuſes, which may by aſſociation excite into action the torpid membranes, which occaſion the head-ach. They may be uſed on the ſame account in amauroſis and in deafneſs.

2. A copious ſalivation without any increaſe of heat often attends hyſteric diſeaſes, and fevers with debility, owing to an inverſion of the lymphatics of the mouth, ſee Claſs I. 1. 2. 6. The ſame occurs in the nauſea, which precedes vomiting; and is alſo excitable by diſagreeable taſtes, as by ſquills, or by nauſeous ſmells, or by nauſeous ideas. Theſe are very ſimilar to the occaſional diſcharge of a thin fluid from the noſtrils of ſome people, which recurs at certain periods, and differs from defective abſorption.

IV. Violent diuretics. 1. If nitre be given from a dram to half an ounce in a morning at repeated draughts, the patient becomes ſickiſh, and much pale water is thrown into the bladder by the inverted action of the urinary lymphatics.

Hence the abſorption in ulcers is increaſed and the cure forwarded, as obſerved by Dr. Rowley.

2. Cantharides taken inwardly ſo ſtimulate the neck of the bladder as to increaſe the diſcharge of mucus, which appears in the urine; but I once ſaw a large doſe taken by miſtake, not leſs than half an ounce or an ounce of the tincture, by which I ſuppoſe the urinary lymphatics were thrown into violent inverted motions, for the patient drank repeated draughts of ſubtepid water to the quantity of a gallon or two in a few hours; and during the greateſt part of that time he was not I believe two entire minutes together without making water. A little blood was ſeen in his water the next day, and a ſoreneſs continued a day longer without any other inconvenience.

3. The decoction of foxglove ſhould alſo be mentioned here, as great effuſions of urine frequently follow its exhibition. See Art. IV. 2. 3. 7. And an infuſion or tincture of tobacco as recommended by Dr. Fowler of York.

4. Alcohol, and opium, if taken ſo as to induce ſlight intoxication, and the body be kept cool, and much diluting liquids taken along with them, have ſimilar effect in producing for a time a greater flow of urine, as moſt intemperate drinkers muſt occaſionally have obſerved. This

circumſtance ſeems to have introduced the uſe of gin, and other vinous ſpirits, as a diuretic, unfortunately in the gravel, amongſt ignorant people; which diſeaſe is generally produced by fermented or ſpirituous liquors, and always increaſed by them.

5. Fear and anxiety are well known to produce a great frequency of making water. A perſon who believed he had made a bad purchaſe concerning an eſtate, told me, that he made five or ſix pints of water during a ſleepleſs night, which ſucceeded his bargain; and it is uſual, where young men are waiting in an antiroom to be examined for college preferment, to ſee the chamber-pot often wanted.

V. Cold ſweats about the head, neck, and arms, frequently attend thoſe, whoſe lungs are oppreſſed, as in ſome dropſies and aſthma. A cold ſweat is alſo frequently the harbinger of death. Theſe are from the inverted motions of the cutaneous lymphatic branches of thoſe parts.

III. Catalogue of Invertentia.

1. Emetics, ipecacuanha, emetic tartar, antimonium tartariſatum, ſquill, ſcilla maritima, carduus benedictus, cnicus acarna, chamomile, anthemis nobilis, white vitriol, vitri-

olum zinci, foxglove, digitalis purpurea, clyſters of tobacco.

II. Violent cathartics, emetic tartar, ſquill, buckthorn, rhamnus catharticus, ſcammonium, convolvulus ſcammonia, gamboge, elaterium, colocynth, cucumis colocynthis, veratrum.

III. Violent errhines and ſialagogues, turpeth mineral, hydragyrus vitriolatus, aſarum europæum, euphorbium, capſicum, veratrum, nauſeous ſmells, nauſeous ideas.

IV. Violent diuretics, nitre, ſquill, ſeneka, cantharides, alcohol, foxglove, tobacco, anxiety.

V. Cold ſudorifics, poiſons, fear, approaching death.

Art. VI.

REVERTENTIA.

I. Those things, which reſtore the natural order of the inverted irritative motions, are termed Revertentia.

1. As muſk, caſtor, aſafœtida, valerian, eſſential oils.

2. Externally the vapour of burnt feathers, of volatile ſalts, or oils, bliſters, ſinapiſms.

Theſe reclaim the inverted motions without increaſing the heat of the body above its natural ſtate, if given in their proper doſes, as in the globus hyſtericus, and palpitation of the heart.

The incitantia revert theſe morbid motions more certainly, as opium and alcohol: and reſtore the natural heat more; but if they induce any degree of intoxication, they are ſucceeded by debility, when their ſtimulus ceaſes.

II. OBSERVATIONS ON THE REVERTENTIA.

I. 1. The hyſteric diſeaſe is attended with inverted motions feebly exerted of the œſophagus, inteſtinal canal and lymphatics of the bladder. Hence the borborigmi, or rumbling of the bowels, owing to their fluid contents deſcending as the air beneath aſcends. The globus hyſtericus conſiſts in the retrograde motion of the œſophagus, and the great flow of urine from that of the lymphatics ſpread on the neck of the bladder; and a copious ſalivation ſometimes happens to theſe patients from the inverſion of the lymphatics of the mouth; and palpitation of the heart owing to weak or incipient inverſion of its motions; and ſyncope, when this occurs in its greateſt degree.

Theſe hyſteric affections are not neceſſarily attended with pain; though it ſometimes happens, that pains, which originate from quieſcence, afflict theſe patients, as the hemicrania, which has erroneouſly been termed the clavus hyſtericus; but which is owing ſolely to the inaction of the membranes of that part, like the pains attending the cold fits of intermittents, and which frequently returns like them at very regular periods of time.

Many of the above ſymptoms are relieved by muſk, caſtor, the fœtid gums, valerian, oleum animale, oil of amber, which act in the uſual doſe without heating the body. The pains, which ſometimes attend theſe conſtitutions, are relieved by the ſecernentia, as eſſential oils in common tooth-ach, and balſam of Peru in the flatulent colic. But the incitantia, as opium, or vinous ſpirit, reclaim theſe morbid inverted motions with more certainty, than the fœtids; and remove the pains, which attend theſe conſtitutions, with more certainty than the ſecernentia; but if given in large doſes, a debility and return of the hyſteric ſymptoms occurs, when the effect of the opium or alcohol ceaſes. Opiates and fœtids joined ſeem beſt to anſwer the purpoſe of alleviating the preſent ſymptoms; and the ſorbentia, by ſtimulating the lymphatics and lacteals into continued action, prevent a relapſe of their inverſion, as Peruvian bark, and the ruſt of iron. See Claſs I. 3. 1. 10.

II. Vomiting conſiſts in the inverted order of the motions of the ſtomach, and œſophagus; and is alſo attended with the inverted motions of a part of the duodenum, when bile is ejected; and of the lymphatics of the ſtomach and fauces, when nauſea attends, and when much lymph is evacuated. Permanent vomiting is for a time relieved by the incitantia, as opium or alcohol; but is liable to return, when their action ceaſes. A bliſter on the back, or on the ſtomach, is more efficacious for reſtraining vomiting by their ſtimulating into action the external ſkin, and by ſympathy affecting the membranes of the ſtomach. In ſome fevers attended with inceſſant vomiting Sydenham adviſed the patient to put his head under the bed-clothes, till a ſweat appeared on the ſkin, as explained in Claſs IV. 1. 1. 3.

In chronical vomiting I have obſerved crude mercury of good effect in the doſe of half an ounce twice a day. The vomitings, or vain efforts to vomit, which ſometimes attend hyſteric or epileptic patients, are frequently inſtantly relieved for a time by applying flour of muſtard-ſeed and water to the ſmall of the leg; and removing it, as ſoon as the pain becomes conſiderable. If ſinapiſms lie on too long, eſpecially in paralytic caſes, they are liable to produce troubleſome ulcers. A plaſter or cataplaſm, with opium and camphor on the region of the ſtomach, will ſometimes revert its retrograde motions.

III. Violent catharſis, as in diarrhœa or dyſentery, is attended with inverted motions of the lymphatics of the inteſtines, and is generally owing to ſome ſtimulating material. This is counteracted by plenty of mucilaginous liquids, as ſolutions of gum arabic, or ſmall chicken broth, to waſh away or dilute the ſtimulating material, which cauſes the diſeaſe. And then by the uſe of the inteſtinal ſorbentia, Art. IV. 2. 5. as rhubarb, decoction of logwood, calcined hartſhorn, Armenian bole; and laſtly, by the incitantia, as opium.

IV. The diabœtes conſiſts in the inverted motions of the urinary lymphatics, which is generally I ſuppoſe owing to the too great action of ſome other branch of the abſorbent ſyſtem. The urinary branch ſhould be ſtimulated by cantharides, turpentine, reſin (which when taken in larger doſes may poſſibly excite it into inverted action), by the ſorbentia and opium. The inteſtinal lymphatics ſhould be rendered leſs active by torpentia, as calcareous earth, earth of alum; and thoſe of the ſkin by oil externally applied over the whole body; and by the warm-bath, which ſhould be of ninety-ſix or ninety-eight degrees of heat, and the patient ſhould ſit in it every day for half an hour.

V. Inverted motions of the inteſtinal canal with all the lymphatics, which open into it, conſtitute the ileus, or iliac paſſion; in which diſeaſe it ſometimes happens, that clyſters are returned by the mouth. After veneſection from ten grains to twenty of calomel make into very ſmall pills; if theſe be rejected, a grain of aloe every hour; a bliſter; crude mercury; warm bath; if a clyſter of iced water?

Many other inverted motions of different parts of the ſyſtem are deſcribed in Claſs I. 3. and which are to be treated in a manner ſimilar to thoſe above deſcribed. It muſt be noted, that the medicines mentioned under number one in the catalogue of revertentia are the true articles belonging to this claſs of medicines. Thoſe enumerated in the other four diviſions are chiefly ſuch things as tend to remove the ſtimulating cauſes, which have induced the inverſion of the motions of the part, as acrimonious contents, or inflammation, of the bowels in diarrhœa, diabetes or in ileus. But it is probable after theſe remote cauſes are deſtroyed, that the fetid gums, muſk, caſtor, and balſams, might be given with advantage in all theſe caſes.

III. Catalogue of Revertentia.

I. Inverted motions, which attend the hyſteric diſeaſe, are reclaimed, 1. By muſk, caſtor. 2. By aſafœtida, galbanum, ſagapenum, ammoniacum, valerian. 3. Eſſential oils of cinnamon, nutmeg, cloves, infuſion of penny-royal, mentha pulegium, peppermint, mentha piperita, ether, camphor. 4. Spirit of hartſhorn, oleum animale, ſponge burnt to charcoal, black ſnuffs of candles, which conſiſt principally of animal charcoal, wood-ſoot, oil of amber. 5. The incitantia, as opium, alcohol, vinegar. 6. Externally the ſmoke of burnt feathers, oil of amber, volatile ſalt applied to the noſtrils, bliſters, ſinapiſms.

II. Inverted motions of the ſtomach are reclaimed by opium, alcohol, bliſters, crude mercury, ſinapiſms, camphor and opium externally, clyſters with aſafœtida.

III. Inverted motions of the inteſtinal lymphatics are reclaimed by mucilaginous diluents, and by inteſtinal ſorbentia, as rhubarb, logwood, calcined hartſhorn, Armenian bole; and laſtly by incitantia, as opium.

IV. Inverted motions of the urinary lymphatics are reclaimed by cantharides, turpentine, reſin, the ſorbentia, and opium, with calcareous earth of alum, by oil externally, warm-bath.

V. Inverted motions of the inteſtinal canal are reclaimed by calomel, aloe, crude mercury, bliſters, warm-bath, clyſters with aſafœtida, clyſters of iced water? or of ſpring water further cooled by ſalt diſſolved in water contained in an exterior veſſel? Where there exiſts an introſuſception of the bowel in children, could the patient be held up for a time by the feet with his head downwards, or be laid with his body on an inclined plane with his head downwards, and crude mercury be injected as a clyſter to the quantity of two or three pounds?

ART. VII.

TORPENTIA.

I. THOSE THINGS, which diminiſh the exertion of the irritative motions, are termed torpentia.

1. As mucus, mucilage, water, bland oils, and whatever poſſeſſes leſs ſtimulus than our uſual food. Diminution of heat, light, ſound, oxygen, and of all other ſtimuli; veneſection, nauſea, and anxiety.

2. Thoſe things which chemically deſtroy acrimony, as calcareous earth, ſoap, tin, alcalies, in cardialgia; or which prevent chemical acrimony, as acid of vitriol in cardialgia, which prevents the fermentation of the aliment in the ſtomach, and its conſequent acidity. Secondly, which deſtroy worms, as calomel, iron filings or ruſt of iron, in the round worms; or amalgama of quickſilver and tin, or tin in very large doſes, in the tape-worms. Will ether in clyſters deſtroy aſcarides? Thirdly, by chemically deſtroying extraneous bodies, as cauſtic alcali, lime, mild alcali in the ſtone. Fourthly, thoſe things which lubricate the veſſels, along which extraneous bodies ſlide, as oil in the ſtone in the urethra, and to expedite the expectoration of hardened mucus; or which leſſen the friction of the contents in the inteſtinal canal in dyſentery or aphtha, as calcined hartſhorn, clay, Armenian bole, chalk, bone-aſhes. Fifthly, ſuch things as ſoften or extend the cuticle over tumors, or phlegmons, as warm water, poultices, fomentations, or by confining the perſpirable matter on the part by cabbage-leaves, oil, fat, bee's-wax, plaſters, oiled ſilk, externally applied.

Theſe decreaſe the natural heat and remove pains occaſioned by exceſs of irritative motions.

II. Observations on the Torpentia.

I. As the torpentia conſiſt of ſuch materials as are leſs ſtimulating than our uſual diet, it is evident, that where this claſs of medicines is uſed, ſome regard muſt be had to the uſual manner of living of the patient both in reſpect to quantity and quality. Hence wounds in thoſe, who have been accuſtomed to the uſe of much wine, are very liable to mortify, unleſs the uſual potation of wine be allowed the patient. And in theſe habits I have ſeen a delirium in a fever cured almoſt immediately by wine; which was occaſioned by the too mild regimen directed by the attendants. On the contrary in great inflammation, the ſubduction of food, and of ſpirituous drink, contributes much to the cure of the diſeaſe. As by theſe means both the ſtimulus from diſtention of the veſſels, as well as that from the acrimony of the fluids, is decreaſed; but in both theſe reſpects the previous habits of diet of the patients muſt be attended to. Thus if tea be made ſtronger, than the patient has uſually drunk it, it belongs to the article ſorbentia; if weaker, it belongs to the torpentia.

II. 1. Water in a quantity greater than uſual diminiſhes the action of the ſyſtem not only by diluting our fluids, and thence leſſening their ſtimulus, but by lubricating the ſolids, for not only parts of our ſolids have their ſliding over each other facilitated by the interpoſition of aqueous particles; but the particles of mucaginous or ſaccharine ſolutions ſlide eaſier over each other by being mixed with a greater portion of water, and thence ſtimulate the veſſels leſs.

At the ſame time it muſt be obſerved, that the particles of water themſelves, and of animal gluten diſſolved in water, as the glue uſed by carpenters, ſlide eaſier over each other by an additional quantity of the fluid matter of heat.

Theſe two fluids of heat and of water may be eſteemed the univerſal ſolvents or lubricants in reſpect to animal bodies, and thus facilitate the circulation, and the ſecretion of the various glands. At the ſame time it is poſſible, that theſe two fluids may occaſionally aſſume an aerial form, as in the cavity of the cheſt, and by compreſſing the lungs may cauſe one kind of aſthma, which is relieved by breathing colder air. An increaſed quantity of heat by adding ſtimulus to every part of the ſyſtem belongs to the article Incitantia.

III. 1. The application of cold to the ſkin, which is only another expreſſion for the diminution of the degree of heat we are accuſtomed to, benumbs the cutaneous abſorbents into inaction;

and by ſympathy the urinary and inteſtinal abſorbents become alſo quieſcent. The ſecerning veſſels continuing their action ſomewhat longer, from the warmth of the blood. Hence the uſual ſecretions are poured into the bladder and inteſtines, and no abſorption is retaken from them. Hence ſprinkling the ſkin with cold water increaſes the quantity of urine, which is pale; and of ſtool, which is fluid; theſe have erroneouſly been aſcribed to increaſed ſecretion, or to obſtructed perſpiration.

The thin diſcharge from the noſtrils of ſome people in cold weather is owing to the torpid ſtate of the abſorbent veſſels of the membrana ſchneideriana, which as above are benumbed ſooner than thoſe, which perform the ſecretion of the mucus.

The quick anhelation, and palpitation of the heart, of thoſe, who are immerſed in cold water, depends on the quieſcence of the external abſorbent veſſels and capillaries. Hence the cutaneous circulation is diminiſhed; and by aſſociation an almoſt univerſal torpor of the ſyſtem is induced; thence the heart becomes incapable to puſh forwards its blood through all the inactive capillaries and glands; and as the terminating veſſels of the pulmonary artery ſuffer a ſimilar inaction by aſſociation, the blood is with difficulty puſhed through the lungs.

Some have imagined, that a ſpaſmodic conſtriction of the ſmaller veſſels took place, and have thus accounted for their reſiſtance to the force of the heart. But there ſeems no neceſſity to introduce this imaginary ſpaſm; ſince thoſe, who are converſant in injecting bodies, find it neceſſary firſt to put them into warm water to take away the ſtiffneſs of the cold dead veſſels; which become inflexible like the other muſcles of dead animals, and prevent the injected fluid from paſſing.

Before the improved knowledge of chemiſtry, and of natural philoſophy, and of the laws of organic life, ſome writers have ſpoken of cold as a ſtimulus to the ſyſtem, inſtead of ſpeaking of it as a diminution of the ſtimulus of heat. But the immediate conſequence of ſtimulus is the exertion of the ſtimulated fibres; now an increaſed application of heat is followed by an increaſed action of the fibres expoſed to it; but an increaſed application of cold is followed by a decreaſed action of the fibres expoſed to it; as appears by the redneſs of our hands when warmed by the fire, and the paleneſs of them, when they have been a while covered with ſnow.

A painful ſenſation ſucceeds the defect as well as the exceſs of the ſtimulus of heat, as mentioned in Vol. I. Sect. IV. 5. and the voluntary exertions of the ſubcutaneous muſcles called ſhuddering, are excited to relieve the pain occaſioned by the torpor of the fibres expoſed to cold; and thoſe of the muſcles ſubſervient to reſpiration are voluntarily excited in ſcreaming to relieve the pain occaſioned by heat, which may have occaſioned the error above mentioned.

Others have ſpoken of a ſedative quality of cold, which is certainly an unphiloſophical expreſſion; as a ſedative power, if it has any diſtinct meaning, ſhould expreſs a power of diminiſhing any unnatural or exceſſive motions of the ſyſtem; but the application of cold diminiſhes the activity of the fibres in general, which may previouſly be leſs than natural, as well as greater.

All the ſame ſymptoms occur in the cold fits of intermittents; in theſe the coldneſs and paleneſs of the ſkin with thirſt evince the diminution of cutaneous abſorption; and the dryneſs of ulcers, and ſmall ſecretion of urine, evince the torpor of the ſecerning ſyſtem; and the anhelation, and coldneſs of the breath, ſhew the terminations of the pulmonary artery to be likewiſe affected with torpor.

After theſe veſſels of the whole ſurface of the body both abſorbent and ſecretory have been for a time torpid by the application of cold water; and all the internal ſecerning and abſorbent ones have been made torpid from their aſſociation with the external; as ſoon as their uſual ſtimulus of warmth is renewed, they are thrown into more than their uſual energy of action; as the hands become hot and painful on approaching the fire after having been immerſed ſome time in ſnow. Hence the face becomes of a red colour in a cold day on turning from the wind, and the inſenſible perſpiration increaſed by repeatedly going into froſty air, but not continuing in it too long at a time.

2. When by the too great warmth of a room or of clothes the ſecretion or perſpirable matter is much increaſed, the ſtrength of the patient is much exhauſted by this unneceſſary exertion of the capillary ſyſtem, and thence of the whole ſecerning and arterial ſyſtem by aſſociation. The diminution of external heat immediately induces a torpor or quieſcence of theſe unneceſſary excretions, and the patient inſtantly feels himſelf ſtrengthened, and exhilarated; the animal power, which was thus waſted in vain, being now applied to more uſeful purpoſes. Thus when the limbs on one ſide are diſabled by a ſtroke of the palſy, thoſe of the other ſide are perpetually in motion. And hence all people bear riding and other exerciſes beſt in cold weather.

Patients in fevers, where the ſkin is hot, are immediately ſtrengthened by cold air; which is therefore of great uſe in fevers attended with debility and heat; but may perhaps be of temporary diſſervice, if too haſtily applied in ſome ſituations of fevers attended with internal topical inflammation, as in peripneumony or pleuriſy, where the arterial ſtrength is too great already, and the increaſed action of the external capillaries being deſtroyed by the cold, the action of the internal inflamed part may be ſuddenly increaſed, unleſs veneſection and other evacuations are applied at the ſame time. Yet in moſt caſes the application of cold is nevertheleſs ſalutary, as by decreaſing the heat of the particles of blood in the cutaneous veſſels, the ſtimulus of them, and the diſtention of the veſſels becomes conſiderably leſſened. In external inflammations, as the ſmall-pox, and perhaps the gout and rheumatiſm, the application of cold air muſt be of great ſervice by decreaſing the action of the inflamed ſkin, though the contrary is too frequently the practice in thoſe diſeaſes. It muſt be obſerved, that for all theſe purpoſes the application of it ſhould be continued a long time, otherwiſe an increaſed exertion follows the temporary torpor, before the diſeaſe is deſtroyed.

The topical application of cold to relieve inflammatory pains, or to deſtroy the too great action of the veſſels, may be uſed with great advantage. In local inflammations, as in the pleuriſy, or ophthalmia, or in local pains from the ſtimulus of an extraneous body, as in gravel deſcending along the ureter, the application of cold on or near the affected part may be uſed with ſalutary effect, as by preſſing on the part a bladder full of cold water with ſalt diſſolving in it; or by the evaporation of ether on it; which may render the veſſels torpid or inactive. But the application of cold to the whole ſkin might increaſe the action of the inflamed veſſels by diminiſhing that of the ſkin and lungs, and thus accumulating a greater quantity of ſenſorial power; and this eſpecially if it was applied previous to evacuations by the lancet or by cathartics.

I am informed that an ingenious and eminent ſurgeon in Shropſhire, when he was himſelf affected with gravel in the ureter, attended with exceſſive and continued pain, found inſtantaneous relief frequently in a day by applying on the painful part a bag of ſnow or pounded ice, and ſuffering it to diſſolve. And in the Memoirs of the Medical Society of London, Vol. V. Mr. Parkinſon of Leiceſter applies cold ingeniouſly to burns, and to inflammations of the eyes, by covering the part with a bladder of the greateſt tenuity, which is kept perpetually moiſtened for many hours, (perhaps 24 or 36) by alcohol or highly rectified ſpirit of wine. In ophthalmia the eyelids were thus covered with thin bladder, and rectified ſpirit of wine was applied by means of a ſponge to the bladder for ſome hours; which ſucceeded, after ſaturnine lotions had been uſed in vain, and deſtroyed the inflammation, as ſoon as two ounces of alcohol had been conſumed. Perhaps ether by its quicker evaporation might be more ſpeedily effectual? or ſnow or ice thawed more haſtily by the addition of acid of nitre?

3. After immerſion in cold water or in cold air the whole ſyſtem becomes more excitable by the natural degree of ſtimulus, as appears from the ſubſequent glow on the ſkin of people otherwiſe pale; and even by a degree of ſtimulus leſs than natural, as appears by their becoming warm in a ſhort time during their continuance in a bath, of about 80 degrees of heat, as in Buxton bath. See Sect. XII. 2. 1. XXXII. 3. 3.

This increaſed exertion happens to the abſorbent veſſels more particularly, as they are firſt and moſt affected by theſe temporary diminutions of heat; and hence like the medicines, which promote abſorption, the cold bath contributes to ſtrengthen the conſtitution, that is to increaſe its irritability; for the diſeaſes attended with weakneſs, as nervous fevers and hyſteric diſeaſes, are ſhewn in Section XXXII. 2. 1. to proceed from a want of irritability, not from an exceſs of it. Hence the digeſtion is greater in froſty weather, and the quantity of perſpiration. For theſe purpoſes the application of cold muſt not be continued too long. For in riding a journey in cold weather, when the feet are long kept too cold, the digeſtion is impaired, and cardialgia produced.

4. If the diminution of external heat be too great, produced too haſtily, or continued too long, the torpor of the ſyſtem either becomes ſo great, that the animal ceaſes to live; or ſo great an energy of motion or orgaſm of the veſſels ſucceeds, as to produce fever or inflammation. This moſt frequently happens after the body has been temporarily heated by exerciſe, warm rooms, anger, or intemperance. Hence colds are produced in the external air by reſting after exerciſe, or by drinking cold water. See Claſs I. 2. 2. 1.

Frequent cold immerſions harden or invigorate the conſtitution, which they effect by habituating the body to bear a diminution of heat on its ſurface without being thrown into ſuch extenſive torpor or quieſcence by the conſent of the veſſels of the ſkin with the pulmonary and glandular ſyſtem; as thoſe experience, who frequently uſe the cold bath. At firſt they have great anhelation and palpitation of heart at their ingreſs into cold water; but by the habit of a few weeks they are able to bear this diminution of heat with little or no inconvenience; for the power of volition has ſome influence over the muſcles ſubſervient to reſpiration, and by its counter efforts gradually prevents the quick breathing, and diminiſhes the aſſociations of the pulmonary veſſels with the cutaneous ones. And thus though the ſame quantity of heat is ſubducted from the ſkin, yet the torpor of the pulmonary veſſels and internal glands does not follow. Hence during cold immerſion leſs ſenſorial power is accumulated, and, in conſequence, leſs exertion of it ſucceeds on emerging from the bath. Whence ſuch people are eſteemed hardy, and bear the common variations of atmoſpheric temperature without inconvenience. See Sect. XXXII. 3. 2.

IV. Veneſection has a juſt title to be claſſed amongſt the torpentia in caſes of fever with arterial ſtrength, known by the fulneſs and hardneſs of the pulſe. In theſe caſes the heat becomes leſs by its uſe, and all exuberant ſecretions, as of bile or ſweat, are diminiſhed, and room is made in the blood-veſſels for the abſorption of mild fluids; and hence the abſorption alſo of new veſſels, or extravaſated fluids, the produce of inflammation, is promoted. Hence veneſection is properly claſſed amongſt the ſorbentia, as like other evacuations it promotes general abſorption, reſtrains hæmorrhages, and cures thoſe pains, which originate from the too great action of the ſecerning veſſels, or from the torpor of the abſorbents. I have more than once been witneſs to the ſudden removal of nervous head-achs by veneſection, though the patient was already exhauſted, pale, and feeble; and to its great uſe in convulſions and madneſs, whether the patient was ſtrong or weak; which diſeaſes are the conſequence of nervous pains; and to its ſtopping long debilitating hæmorrhages from the uterus, when other means had been in vain eſſayed. In inflammatory pains, and inflammatory hæmorrhages, every one juſtly applies to it, as the certain and only cure.

V. When the circulation is carried on too violently, as in inflammatory fevers, thoſe medicines, which invert the motions of ſome parts of the ſyſtem, retard the motions of ſome other parts, which are aſſociated with them. Hence ſmall doſes of emetic tartar, and ipecacuanha, and large doſes of nitre, by producing nauſea debilitate and leſſen the energy of the circulation, and are thence uſeful in inflammatory diſeaſes. It muſt be added, that if nitre be ſwallowed in powder, or ſoon after it is diſſolved, it contributes to leſſen the circulation by the cold it generates, like ice-water, or the external application of cold air.

VI. The reſpiration of air mixed with a greater proportion of azote than is found in the common atmoſphere, or of air mixed with hydrogen, or with carbonic acid gas, ſo that the quantity of oxygen might be leſs than uſual, would probably act in caſes of inflammation with great advantage. In conſumptions this might be moſt conveniently and effectually applied, if a phthiſical patient could reſide day and night in a porter or ale brewery, where great quantities of thoſe liquors were perpetually fermenting in vats or open barrels; or in ſome great manufactory of wines from raiſins or from ſugar.

Externally the application of carbonic acid gas to cancers and other ulcers inſtead of atmoſpheric air may prevent their enlargement, by preventing the union of oxygen with the matter, and thus producing a new contagious animal acid.

III. CATALOGUE OF TORPENTIA.

1. Veneſection. Arteriotomy.
2. Cold water, cold air, reſpiration of air with leſs oxygen.
3. Vegetable mucilages.
   a. Seeds —Barley, oats, rice, young peas, flax, cucumber, melon, &c.
   b. Gums.—Arabic, tragacanth, Senegal, of cherry-trees.
   c. Roots—Turnip, potatoe, althea, orchis, ſnow-drop.
   d. Herbs —Spinach, brocoli, mercury.
4. Vegetable acids, lemon, orange, currants, gooſeberries, apples, grape, &c.
5. Animal mucus, hartſhorn jelly, veal broth, chicken water, oil? fat? cream?
6. Mineral acids, of vitriol, nitre, ſea-ſalt.

1 7.

7. Silence, darkneſs.
8. Invertentia in ſmall doſes, nitre, emetic tartar, ipecacuanha given ſo as to induce nauſea.
9. Antacids.—Soap, tin, alcalies, earths.
10. Medicines preventive of fermentation, acid of vitriol.
11. Anthelmintics.—Indian pink, tin, iron, cowhage, amalgama, ſmoak of tobacco.
12. Lithontriptics, lixiv. ſaponarium, aqua calcis, fixable air.
13. Externally, warm bath, and poultices, oil, fat, wax, plaſters, oiled ſilk, carbonic acid gas on cancers, and other ulcers.

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DIRECTIONS TO THE BINDER.

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6. —— Conſiſting of the word BANKS in blue on a yellow ground, at Sect. XL. 10. 5.

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